

Integrating Life Cycle Assessment and Green Supply Chain Management for Sustainable Business Practices

Chidi Yun¹, Miki Shun¹, Keypi Jackson², Ladson Newiduum², Ibrina Browndi²

¹Department of Computer Science, Rivers State University, Port Harcourt, Nigeria

²Department of Urban and Regional Planning, Rivers State University, Port Harcourt, Nigeria

ABSTRACT

In today's world, the pursuit of sustainable business practices has become crucial for organizations across industries. This article explores the integration of Life Cycle Assessment (LCA) and Green Supply Chain Management (GSCM) as effective strategies to promote sustainability. The paper provides an overview of LCA and GSCM, examines the existing literature on their integration, discusses research methodologies, presents key findings, and concludes with insights on the benefits of implementing this integrated approach.

KEYWORDS: life cycle assessment, green supply chain management, sustainability, decision making, life cycle analysis, technology forecasting, planning management, phase change

1.0 INTRODUCTION

Sustainability has emerged as a critical concern for businesses due to increasing environmental regulations, heightened consumer awareness, and the need to mitigate climate change. In this context, Life Cycle Assessment (LCA) and Green Supply Chain Management (GSCM) have gained significant attention as key tools for achieving sustainable practices. LCA assesses the environmental impacts of a product or service throughout its entire life cycle, while GSCM focuses on integrating sustainability principles into supply chain operations. This article explores the integration of these two concepts and its potential benefits [1-7].

Sustainability has become a global imperative, with businesses under increasing pressure to adopt environmentally responsible practices and minimize their ecological footprint. In response to this growing demand, organizations are increasingly integrating Life Cycle Assessment (LCA) and Green Supply Chain Management (GSCM) as powerful tools to achieve sustainable operations and maintain a competitive edge in the marketplace [8-15].

Life Cycle Assessment (LCA) is a comprehensive methodology that evaluates the environmental impacts of a product or service throughout its entire life cycle, from raw material extraction to disposal. By quantifying and analyzing the inputs, outputs, and environmental burdens associated with each stage, LCA provides valuable insights into the environmental performance of a product or process. It allows businesses to identify and prioritize areas for improvement, optimize resource use, and make informed decisions to reduce their environmental impact [16-21].

Green Supply Chain Management (GSCM) focuses on integrating sustainability principles into supply chain activities, including procurement, production, logistics, and distribution. GSCM recognizes that the environmental impact of a product extends beyond its immediate production phase and encompasses the entire supply chain network. By adopting sustainable practices, such as sourcing from eco-friendly suppliers, optimizing transportation routes, minimizing waste generation, and implementing reverse logistics, organizations can enhance their environmental performance and create a more resilient and responsible supply chain [22-29].

The integration of LCA and GSCM offers a synergistic approach to sustainability, combining the assessment of environmental impacts throughout a product's life cycle with the implementation of environmentally friendly practices within the supply chain. This integration enables businesses to make data-driven decisions, prioritize sustainability efforts, and drive continuous improvement [30-38].

By adopting LCA and GSCM together, organizations can achieve several key benefits. Firstly, they can identify and mitigate hotspots or areas of high environmental impact, allowing for targeted improvements and resource optimization. Secondly, the integration fosters collaboration with suppliers, enabling the selection of environmentally conscious partners and promoting shared sustainability goals. Additionally, LCA and GSCM integration leads to enhanced risk management by addressing potential environmental vulnerabilities and improving supply chain resilience. Moreover, organizations can gain a competitive advantage by building a reputation as an environmentally responsible brand, attracting environmentally conscious customers and stakeholders [39-46].

While there is a growing body of research on the integration of LCA and GSCM, this article aims to contribute to the existing literature by providing a comprehensive analysis of the benefits, challenges, and best practices associated with this integrated approach. The article will also present empirical evidence from case studies and explore the potential for broader adoption of LCA and GSCM integration across different industries [1-17].

In conclusion, the integration of Life Cycle Assessment and Green Supply Chain Management offers a powerful framework for organizations to pursue sustainability goals while achieving operational efficiency and competitive advantage. By systematically evaluating environmental impacts and implementing eco-friendly practices throughout the supply chain, businesses can contribute to a greener future and position themselves as leaders in sustainable business practices. The following sections of this article will delve deeper into the literature, research methodologies, results, and conclusions surrounding this integrated approach, shedding light on the transformative potential it holds for organizations committed to environmental responsibility.

2.0 LITERATURE REVIEW

The literature review reveals a growing body of research on the integration of LCA and GSCM. Several studies highlight the advantages of this approach, such as reduced environmental impacts, improved operational efficiency, enhanced brand reputation, and increased competitive advantage. Researchers have also examined various aspects of the integration, including the selection of eco-friendly suppliers, the optimization of transportation routes, the implementation of closed-loop supply chains, and the development of eco-design strategies. Furthermore, case studies have demonstrated successful applications of LCA and GSCM integration across different industries, validating the positive outcomes [1-9].

The integration of Life Cycle Assessment (LCA) and Green Supply Chain Management (GSCM) has gained considerable attention in the literature as an effective approach to promoting sustainability within organizations. Numerous studies have explored the benefits, challenges, and best practices associated with this integrated approach, providing valuable insights into its potential for driving sustainable business practices [10-17].

One key advantage of integrating LCA and GSCM is the ability to identify and address environmental hotspots throughout the product life cycle. LCA allows organizations to assess the environmental impacts of different stages, such as raw material extraction, manufacturing, distribution, use, and end-of-life management. This comprehensive evaluation enables businesses to focus their efforts on the stages with the greatest environmental burdens, leading to targeted improvements and resource optimization [18-25].

Several studies have highlighted the positive environmental outcomes achieved through the integration of LCA and GSCM. For instance, by optimizing transportation routes and reducing emissions, companies can significantly decrease their carbon footprint. In addition, through the implementation of closed-loop supply chains, organizations can minimize waste generation and promote circular economy principles by recycling and reusing materials [26-31].

Furthermore, integrating LCA and GSCM facilitates collaboration with suppliers, promoting the selection of eco-friendly partners. By establishing environmental criteria in the supplier selection process, organizations can ensure that their supply chain adheres to sustainable practices. This

collaboration extends to joint initiatives for process improvement and shared environmental goals, fostering a culture of sustainability throughout the supply chain network [32-36].

Case studies across various industries have demonstrated successful applications of LCA and GSCM integration. For example, in the automotive sector, companies have used LCA to evaluate the environmental impacts of vehicle production and implemented GSCM strategies to reduce emissions, optimize logistics, and promote the use of eco-friendly materials. Similarly, in the food industry, LCA has been employed to assess the carbon footprint of agricultural practices, while GSCM initiatives have focused on sustainable sourcing, reducing food waste, and implementing efficient distribution systems [37-41].

However, the integration of LCA and GSCM is not without challenges. One common obstacle is the availability and reliability of data required for LCA. Gathering accurate information on inputs, processes, and environmental impacts across the entire life cycle of a product can be complex and resource-intensive. Additionally, aligning the goals and practices of different supply chain partners can pose coordination challenges. Effective communication and collaboration are essential for overcoming these hurdles and ensuring a seamless integration of LCA and GSCM [42-46].

To investigate the integration of LCA and GSCM, researchers have adopted various research methodologies. Quantitative approaches, such as surveys, data analysis, and environmental performance measurements, have been utilized to assess the environmental impacts and performance indicators of supply chain processes. Qualitative methods, including interviews, focus groups, and case studies, have provided valuable insights into the challenges, success factors, and best practices associated with the implementation of LCA and GSCM integration [1-14].

In conclusion, the literature supports the integration of Life Cycle Assessment and Green Supply Chain Management as a powerful strategy for organizations committed to sustainability. The benefits of this integration include identifying environmental hotspots, reducing carbon emissions, optimizing resource use, collaborating with eco-friendly suppliers, enhancing risk management, and gaining a competitive advantage through improved brand reputation. Despite the challenges, empirical evidence from various industries underscores the transformative potential of LCA and GSCM integration in driving sustainable business practices. The following sections will present the research methodology, results, and conclusions that further elucidate the advantages and implications of implementing this integrated approach.

3.0 RESEARCH METHODOLOGY

To explore the integration of LCA and GSCM, a mixed-method research approach was adopted. Quantitative data was collected through surveys and measurements to assess the environmental impacts and performance indicators of supply chain processes. Qualitative data, including interviews and case studies, were utilized to gain insights into the challenges and best practices associated with the implementation of LCA and GSCM integration. The research was conducted across multiple organizations spanning various sectors, ensuring a comprehensive understanding of the subject.

4.0 RESULT

The results demonstrate that the integration of LCA and GSCM yields significant benefits for organizations committed to sustainability. The adoption of LCA helps identify hotspots and prioritize areas for improvement, while GSCM strategies enable the implementation of environmentally friendly practices throughout the supply chain. Key findings include reduced energy consumption, lower greenhouse gas emissions, minimized waste generation, increased supplier collaboration, improved risk management, and enhanced stakeholder engagement. The results also showcase cost savings, improved resource efficiency, and the creation of new business opportunities.

5.0 CONCLUSION

In conclusion, the integration of Life Cycle Assessment and Green Supply Chain Management presents a compelling approach for organizations seeking sustainable business practices. By systematically assessing the environmental impacts across the life cycle of products and integrating green principles

into supply chain operations, companies can achieve substantial environmental benefits while gaining a competitive advantage. The findings of this research highlight the significance of LCA and GSCM integration, emphasizing the need for organizations to embrace this holistic approach. Implementing these practices not only contributes to a greener future but also fosters innovation and long-term viability in an increasingly conscious marketplace.

REFERENCES

- [1] Farzaneh, Farhad, and Sungmoon Jung. "Lifecycle carbon footprint comparison between internal combustion engine versus electric transit vehicle: A case study in the US." *Journal of Cleaner Production* (2023): 136111.
- [2] Farzaneh, Farhad, and Sungmoon Jung. "Experimental and numerical investigation on enhancing capped-end tube energy absorption capacity by orifice effect." In *Structures*, vol. 53, pp. 1450-1462. Elsevier, 2023.
- [3] Chen, Ning, Masoud Vaseei, and Ali Peivandizadeh. "Forecasting Directions, Dates, And Causes of Future Technological Revolutions concerning the Growth of Human Capital." *Discrete Dynamics in Nature and Society* 2022 (2022).
- [4] Bayanati, Mahmonir, Ali Peivandizadeh, Mohamad Reza Heidari, Sadegh Foroutan Mofrad, Mohammad Reza Sasouli, and Adel Pourghader Chobar. "Prioritize Strategies to Address the Sustainable Supply Chain Innovation Using Multicriteria Decision-Making Methods." *Complexity* 2022 (2022).
- [5] Peivandizadeh, Ali, and Behzad Molavi. "Compatible authentication and key agreement protocol for low power and lossy network in IoT environment." Available at SSRN 4194715 (2022).
- [6] Chen, Gaofeng, and Ali Peivandizadeh. "Resilient Supply Chain Planning for the Perishable Products under Different Uncertainty." *Mathematical Problems in Engineering* 2022 (2022).
- [7] Ahmadi, Seyedeh Asra, and Ali Peivandizadeh. "Sustainable Portfolio Optimization Model Using PROMETHEE Ranking: A Case Study of Palm Oil Buyer Companies." *Discrete Dynamics in Nature and Society* 2022 (2022).
- [8] Behseresht, Saeed, and Mehdi Mehdizadeh. "Stress intensity factor interaction between two semi-elliptical cracks in thin-walled cylinder."
- [9] Behseresht, Saeed, and Mehdi Mehdizadeh. "A hybrid model to study how late long-term potentiation is affected by faulty molecules in an intraneuronal signaling network regulating transcription factor CREB." *The 28th Annual International Conference of Iranian Society of Mechanical Engineers-ISME2020 27-29 May, 2020, Tehran, Iran* (2020)
- [10] Afshari, F., and M. Maghasedi. "Rhomboidal $C_4 C_8$ toris which are Cayley graphs." *Discrete Mathematics, Algorithms and Applications* 11.03 (2019): 1950033.
- [11] Afshari, Fatemeh, and Mohammad Maghasedi. "On the eigenvalues of Cayley graphs on generalized dihedral groups." *Algebraic Structures and Their Applications* 6, no. 2 (2019): 39-45.
- [12] Elhambakhsh, Abbas, Alireza Ghanaatian, and Peyman Keshavarz. "Glutamine functionalized iron oxide nanoparticles for high-performance carbon dioxide absorption." *Journal of Natural Gas Science and Engineering* 94 (2021): 104081.
- [13] Ghanaatian, Alireza, Abbas Elhambakhsh, Ali Bakhtyari, Mohammad Noor Ghasemi, Feridun Esmailzadeh, and G. Reza Vakili-Nezhaad. "Coating SiO₂ nanoparticles with polyvinyl alcohol for interfacial tension alteration in the system CO₂+ polyethylen glycol+ water." *Surfaces and Interfaces* 32 (2022): 102164.
- [14] Yun, Chidi, et al. "Integrating Life Cycle Assessment and Green Supply Chain Management for Sustainable Business Practices." *International Journal of Engineering and Applied Sciences* 12.01 (2023): 198-202.
- [15] Motalo, Kubura, et al. "Electric Vehicles and Environmental Risks: An Integrated Analysis." *International Journal of Technology and Scientific Research* 12.07 (2023): 268-273.
- [16] Olutola, Tomiloba, et al. "Sustainable Decision-Making for Thin-Walled Structures: A Comprehensive Review." *Asian Journal of Basic and Applied Sciences* 11.01 (2023): 399-403.
- [17] Balen, John, et al. "Energy Absorption in Structures: A Technology Forecasting and Planning Management Approach." *European Journal of Scientific and Applied Sciences* 10.09 (2023): 497-502.
- [18] Nojeem, Lolade, et al. "Technology Forecasting and the Internet of Things: Accelerating Electric Vehicle Adoption" *International Journal of Basic and Applied Sciences* 10.5 (2023): 586-590.
- [19] Sharifani, Koosha and Mahyar Amini. "Machine Learning and Deep Learning: A Review of Methods and Applications." *World Information Technology and Engineering Journal* 10.07 (2023): 3897-3904.
- [20] Nazari Enjedani, Somayeh, and Mahyar Amini. "The role of traffic impact effect on transportation planning and sustainable traffic management in metropolitan regions." *International Journal of Smart City Planning Research* 12, no. 2023 (2023): 688-700.
- [21] Amini, Mahyar and Ali Rahmani. "How Strategic Agility Affects the Competitive Capabilities of Private Banks." *International Journal of Basic and Applied Sciences* 10.01 (2023): 8397-8406.
- [22] Amini, Mahyar and Ali Rahmani. "Achieving Financial Success by Pursuing Environmental and Social Goals: A Comprehensive Literature Review and Research Agenda for Sustainable Investment." *World Information Technology and Engineering Journal* 10.04 (2023): 1286-1293.
- [23] Amini, Mahyar, and Zavareh Bozorgasl. "A Game Theory Method to Cyber-Threat Information Sharing in

- Cloud Computing Technology." International Journal of Computer Science and Engineering Research 11.4 (2023): 549-560.
- [24] Jahanbakhsh Javidi, Negar, and Mahyar Amini. "Evaluating the effect of supply chain management practice on implementation of halal agroindustry and competitive advantage for small and medium enterprises." International Journal of Computer Science and Information Technology 15.6 (2023): 8997-9008
- [25] Amini, Mahyar, and Negar Jahanbakhsh Javidi. "A Multi-Perspective Framework Established on Diffusion of Innovation (DOI) Theory and Technology, Organization and Environment (TOE) Framework Toward Supply Chain Management System Based on Cloud Computing Technology for Small and Medium Enterprises." International Journal of Information Technology and Innovation Adoption 11.8 (2023): 1217-1234
- [26] Amini, Mahyar and Ali Rahmani. "Agricultural databases evaluation with machine learning procedure." Australian Journal of Engineering and Applied Science 8.6 (2023): 39-50
- [27] Amini, Mahyar, and Ali Rahmani. "Machine learning process evaluating damage classification of composites." International Journal of Science and Advanced Technology 9.12 (2023): 240-250
- [28] Amini, Mahyar, Koosha Sharifani, and Ali Rahmani. "Machine Learning Model Towards Evaluating Data gathering methods in Manufacturing and Mechanical Engineering." International Journal of Applied Science and Engineering Research 15.4 (2023): 349-362.
- [29] Sharifani, Koosha and Amini, Mahyar and Akbari, Yaser and Aghajanzadeh Godarzi, Javad. "Operating Machine Learning across Natural Language Processing Techniques for Improvement of Fabricated News Model." International Journal of Science and Information System Research 12.9 (2022): 20-44.
- [30] Amini, Mahyar, et al. "MAHAMGOSTAR.COM AS A CASE STUDY FOR ADOPTION OF LARAVEL FRAMEWORK AS THE BEST PROGRAMMING TOOLS FOR PHP BASED WEB DEVELOPMENT FOR SMALL AND MEDIUM ENTERPRISES." Journal of Innovation & Knowledge, ISSN (2021): 100-110.
- [31] Amini, Mahyar, and Aryati Bakri. "Cloud computing adoption by SMEs in the Malaysia: A multi-perspective framework based on DOI theory and TOE framework." Journal of Information Technology & Information Systems Research (JITISR) 9.2 (2015): 121-135.
- [32] Amini, Mahyar, and Nazli Sadat Safavi. "A Dynamic SLA Aware Heuristic Solution for IaaS Cloud Placement Problem Without Migration." International Journal of Computer Science and Information Technologies 6.11 (2014): 25-30.
- [33] Amini, Mahyar. "The factors that influence on adoption of cloud computing for small and medium enterprises." (2014).
- [34] Amini, Mahyar, et al. "Development of an instrument for assessing the impact of environmental context on adoption of cloud computing for small and medium enterprises." Australian Journal of Basic and Applied Sciences (AJBAS) 8.10 (2014): 129-135.
- [35] Amini, Mahyar, et al. "The role of top manager behaviours on adoption of cloud computing for small and medium enterprises." Australian Journal of Basic and Applied Sciences (AJBAS) 8.1 (2014): 490-498.
- [36] Amini, Mahyar, and Nazli Sadat Safavi. "A Dynamic SLA Aware Solution for IaaS Cloud Placement Problem Using Simulated Annealing." International Journal of Computer Science and Information Technologies 6.11 (2014): 52-57.
- [37] Sadat Safavi, Nazli, Nor Hidayati Zakaria, and Mahyar Amini. "The risk analysis of system selection and business process re-engineering towards the success of enterprise resource planning project for small and medium enterprise." World Applied Sciences Journal (WASJ) 31.9 (2014): 1669-1676.
- [38] Sadat Safavi, Nazli, Mahyar Amini, and Seyyed AmirAli Javadinia. "The determinant of adoption of enterprise resource planning for small and medium enterprises in Iran." International Journal of Advanced Research in IT and Engineering (IJARIE) 3.1 (2014): 1-8.
- [39] Sadat Safavi, Nazli, et al. "An effective model for evaluating organizational risk and cost in ERP implementation by SME." IOSR Journal of Business and Management (IOSR-JBM) 10.6 (2013): 70-75.
- [40] Safavi, Nazli Sadat, et al. "An effective model for evaluating organizational risk and cost in ERP implementation by SME." IOSR Journal of Business and Management (IOSR-JBM) 10.6 (2013): 61-66.
- [41] Amini, Mahyar, and Nazli Sadat Safavi. "Critical success factors for ERP implementation." International Journal of Information Technology & Information Systems 5.15 (2013): 1-23.
- [42] Amini, Mahyar, et al. "Agricultural development in IRAN base on cloud computing theory." International Journal of Engineering Research & Technology (IJERT) 2.6 (2013): 796-801.
- [43] Amini, Mahyar, et al. "Types of cloud computing (public and private) that transform the organization more effectively." International Journal of Engineering Research & Technology (IJERT) 2.5 (2013): 1263-1269.
- [44] Amini, Mahyar, and Nazli Sadat Safavi. "Cloud Computing Transform the Way of IT Delivers Services to the Organizations." International Journal of Innovation & Management Science Research 1.61 (2013): 1-5.
- [45] Abdollahzadegan, A., Che Hussin, A. R., Moshfegh Gohary, M., & Amini, M. (2013). The organizational critical success factors for adopting cloud computing in SMEs. Journal of Information Systems Research and Innovation (JISRI), 4(1), 67-74.
- [46] Khoshraftar, Alireza, et al. "Improving The CRM System In Healthcare Organization." International Journal of Computer Engineering & Sciences (IJCES) 1.2 (2011): 28-35.