NIPES

Journal of Energy Technology and Environment

Journal homepage: www.nipesjournals.org.ng

Exploring Carbon Neutrality Strategies and Challenges in Manufacturing Supply Chains: A Mixed-Methods Approach

A.A Fasasi

Department of Mechanical Engineering, Ladoke Akintola University of Technology Ogbomosho, Oyo State, Nigeria.
School of Engineering, College of Science and Engineering, University of Derby, England, United Kingdom
Corresponding Author: jb.hopeengineer@gmail.com

Article information

Article History
Received 16 April 2024
Revised 28 April 2024
Accepted 1 May 2024
Available online 31 May 2024

Keywords:
Chain Management, Challenges, Strategies, Sustainability, Communication

https://doi.org/10.5281/zenodo.11408126

https://nipes.org

Abstract

The objective of manufacturing supply chains achieving carbon neutrality requires in-depth knowledge as well as practical solutions to challenges and the adoption of sustainable practices. This study investigates the challenges and strategies related to carbon neutrality projects using a mixed-methods methodology that integrates expert interviews and survey questionnaires. The approach to carbon neutrality is hindered by issues like lack of visibility, overreliance on data, and high upfront costs. However, effective communication, collaboration, and extensive carbon management techniques to overcome these challenges are required. The study emphasises the value of establishing alliances, funding sustainability education, and pushing for regulatory compliance to effectively navigate evolving government regulations. Embracing green innovation and technologies also presents chances to lower emissions and improve sustainability through the supply chain. Stakeholders may help mitigate climate change and promote environmental stewardship in the manufacturing sector by emphasizing sustainability. This study offers practical insights and recommendations to help stakeholders navigate the challenges of achieving carbon neutrality and establish opportunities for a more sustainable future. By collaborating and implementing strategic initiatives, stakeholders can accelerate the transition to carbon neutrality and promote a more resilient and environmentally friendly global economy.

1. Introduction

Among the main contributors to climate change, greenhouse gas emissions, particularly those of carbon dioxide (CO2), are considered to be responsible for the majority of the global environmental issues [1]. An effective method for studying carbon emissions, which are a major topic in the world due to energy consumption, is the multi-factor hierarchical approach [2, 3, 4]. With most research using this approach, carbon neutrality tools play a significant role in reducing carbon emissions [5, 6]. For instance, Xu et al. [7] examined the use of emission reduction and energy conservation measures to achieve carbon neutrality.

With the use of the distinction in differential approach, they demonstrated a significant decrease in carbon emissions. Using Qingdao, China as an example, Zhao et al. [8] carried out a research

investigation on carbon neutrality in the housing sector. They concentrated on the socioeconomic factors that influence residents to act in a low-carbon attitude. They discovered that residents' low-carbon conduct is significantly influenced by their income and age. The major cause of the increasing global warming, has been established to be increased carbon emissions, which are closely correlated with increased human activity, especially in the industrial sector [9]. Global sustainability is currently under severe threat due to increasing global warming and fluctuating biodiversity.

Researchers, practitioners, and scientists from various fields came together to offer suggestions on how to preserve environmental sustainability. King and Lenox [10] asserted that industries' irresponsible and unplanned actions could pose a danger to environmental sustainability. Manufacturers are now attempting to reduce their adverse impacts on the environment by incorporating sustainability principles into their supply chain processes. Sarkis and Dou [11] state that the incorporation of aspects of the supply chain into business environmental management, is known as "Green Supply Chain". Supply chain management (SCM) is a broad topic that requires environmental consideration [12]. Sun et al. [13] used an optimization process to address the obstacles to green supply chain management (GSCM), taking into account environmental factors in SCM. Their ideal route to GSCM offers managers more effective means of reducing carbon emissions. Reducing a company's carbon footprint requires supply chain management (SCM) and supply chain engineering [14]. Supply chains are largely accountable for greenhouse gas (GHG) emissions due to the transportation of materials and goods, the energy required for manufacturing and distribution, and the disposal of waste [15, 16]. Companies can minimize their carbon footprint and help create a more sustainable future by putting sustainable supply chain practices into effect. For instance, they can acquire supplies from low-carbon sources, optimize logistics to lower transportation emissions, and use more ecologically friendly materials to reduce packaging waste.

In supply chain networks, the main sources of greenhouse gas emissions are manufacturing and logistical activities. Although the phrase "carbon neutrality" has not been utilised, early studies examined low-carbon techniques at the supply chain level. Zhu and Geng [17] researched the factors that encourage and hinder Chinese firms from putting emission reduction strategies into place throughout expansive supply chains. Internal considerations are considered a major barrier to implementing low-carbon efforts, as most manufacturing organisations prioritise financial rewards over having the necessary resources and competencies. Furthermore, Subramanian and Abdulrahman [18]. confirmed that the adoption of low carbon methods could result in significant performance improvements for manufacturing enterprises, including the ability to rethink products.

This study aims to thoroughly analyse the strategies and challenges involved in implementing carbon neutrality in manufacturing supply chains. The study intends to give actionable advice to stakeholders and identify broad perspectives on the issues surrounding carbon neutrality through a mixed-method approach that integrates expert interviews and survey questionnaires. This research advances sustainable practices in supply chain management, promoting environmental stewardship and easing the shift to a low-carbon economy by clarifying the challenges and strategies related to achieving carbon neutrality.

1.1 Navigating Carbon Neutrality Challenges in Supply Chain Management

Achieving carbon neutrality through supply chain management, requires a great deal of effort and collaboration from a variety of stakeholders, including manufacturers, suppliers, logistics companies, and retailers. The goal of achieving carbon neutrality is hampered by several issues and challenges, despite the increased public interest in minimising carbon emissions and addressing climate change. Industries face substantial obstacles in their efforts to become carbon neutral due to

the lack of control and visibility over their supply chain which is made up of several layers of suppliers that render it challenging to track emissions and assure compliance [19, 20].

Complexity is further increased by the absence of uniformity in accounting and emissions reporting procedures throughout the supply chain [19]. Setting demanding decarbonisation targets is further complicated by an over-reliance on secondary data and inadequate or incorrect data from suppliers and customers [19]. Green supply chain management (GSCM) encounters challenges when identifying ecologically sensitive industries and clusters due to complex supply chain networks [20, 21]. It is challenging for retailers especially to choose efficient emissions reduction alternatives because they must balance holding costs, shipping expenses, and carbon emissions costs [22]. Moreover, high operational costs contribute to making it increasingly challenging for supply chain stakeholders to put effective emissions reduction plans into practice [23]. Furthermore, a recent study found that the high upfront cost of investments is the main barrier preventing companies from being carbon neutral [24]. Technical know-how and operational capability are necessary to reach carbon neutrality, and both may be insufficient in some companies [19, 23].

Furthermore, increasing customer knowledge of the significance of carbon neutrality is an issue for companies seeking to achieve carbon neutrality [25]. Every stakeholder group, including suppliers, customers, employees, and consumers, is affected by this issue. To achieve carbon neutrality, communication and collaboration between various stakeholders, such as suppliers, consumers, regulators, and non-governmental organizations are crucial [16, 26]. Consequently, overcoming these challenges necessitates a coordinated effort and an all-encompassing strategy throughout the supply chain.

1.2 Carbon Neutrality Supply Chain Management Strategies

Numerous studies emphasise that achieving carbon neutrality in supply chain management requires a diverse strategy. In support of the creation of sustainable supply chains, Mallidis et al. [27] stress the critical role that instruments and methods play in assessing an organization's carbon footprint and streamlining processes to lower it. Additionally, Shaw et al. [28] draw attention to the potential of current methods and technologies for estimating carbon footprints throughout supply chains. They provide a multi-objective programming approach that aims to optimise both the direct and indirect carbon emissions and the overall cost of the supply chain. According to Garcia-Alvarado et al. [29], strategic decisions are essential for managing the complexities of carbon reduction inside the cap-and-trade system. The significance of striking a balance between environmental and economic objectives through carbon management strategies, capacity expansion, and reduction measures is highlighted by their findings. Galve et al. [30] present a novel strategy that makes use of a mixed-integer sustainable auto-routing system to optimise drone delivery for last-mile logistics.

This approach effectively lowers supply chain costs and fuel consumption. Hossain, Sohail, and Ng [31] add to the subject by providing a systematically way to find sustainable procurement strategies for building supplies. Aljuneidi and Bulgak [32] support the use of reverse logistics in conjunction with hybrid manufacturing systems to reduce carbon emissions and transportation expenses. Zhang et al. [33] highlight the transformative capacity of integrating renewable energy sources to mitigate carbon footprints and energy costs, consequently fortifying companies. reputation as ecologically conscious organisations. Glock and Kim [34] investigated several measures to reduce carbon emissions, including reduced trip spacing, demand consolidation, and mode choice for transportation. Blanco, Caro, and Corbett [35] highlighted that effective emission reduction techniques require coordination within the supply chain. The significance of collaborating with suppliers and partners in promoting sustainability across the supply chain is emphasised by Bai, Sarkis, and Dou [36]. Blanco, Caro, and Corbett [35] also stress the strategic importance of

quantifying emissions for goal-setting and decision-making in carbon reduction projects, in addition to immediate operational benefits. Lastly, Zhi et al. [23] state that government regulations play a critical role in encouraging companies to reduce their greenhouse gas emissions and advancing the goal of being carbon neutral. All these studies emphasise how difficult it is to achieve carbon neutrality in supply chain management and how numerous strategies and collaborations are required to get through this challenging situation. The research indicates that achieving carbon neutrality in supply chain management poses significant challenges, including lack of control and visibility over the supply chain, complexity in emissions tracking, reliance on inadequate data, and high upfront investment costs.

The studies indicate a number of strategies to address these challenges, such as integrating renewable energy sources, utilising innovative technologies for emissions assessment, strategic decision-making to balance environmental and economic objectives, and working with partners and suppliers to advance sustainability. According to the research, companies may effectively reduce emissions, navigate complex supply chain networks, overcome challenges in the pursuit of achieving carbon neutral by implementing all of these strategies into practice. In conclusion, this will help them advance towards to a sustainable and carbon neutral future.

2 Methodology

This research employed a mixed-methods approach to comprehensively analyse the context of challenges and strategies associated with integrating carbon neutrality in manufacturing supply chains. A detailed literature analysis on addressing carbon neutrality challenges in supply chain management and carbon-neutral supply chain strategies established the basis for the interview and survey questions. The research featured open-ended questions with key stakeholders, such as researchers, industry professionals, policymakers, and environmental experts who were selected based on their different areas of expertise. These interviews explored the details of carbon neutrality, aiming to identify motivations, emerging opportunities, and significant challenges. Recurring themes were identified in the interview transcripts through thematic analysis, which gave the research more depth and perspective. Simultaneously, a targeted sample of qualified stakeholders (Carbon Auditor, Environmental Consultant, Consumer Analyst, Environmental Engineer etc.) on carbon neutrality was sent a survey questionnaire.

This survey was designed to obtain quantitative responses that offered a more comprehensive view of perspectives and trends towards carbon neutrality. The Ranking of Relative Importance Index (RII) was utilised to quantitatively analyse the views of respondents through the use of closed-ended questions. The integration of results from expert interviews and survey questionnaires offered an extensive understanding of the diverse challenges and strategies creating the carbon neutrality setting, enhancing our expertise in this vital environmental technology field. Out of the 132 surveys distributed over two months, 66 responses were gathered. Expert interviews were conducted over the phone, and the questionnaires were distributed via social media and professional platforms.

3. Results And Discussions

3.1 Expert Interview

This investigation utilised thematic analysis as a means of investigating the strategies and challenges associated with the integration of carbon neutrality into manufacturing supply chains. Thematic analysis is a qualitative research method used to identify, analyze, and interpret patterns (themes) within data. Recurring themes were found by methodically going over survey responses and expert

interview transcripts, which gave significant insight into the challenges of being carbon-neutral. Thematic analysis, as emphasised by Braun and Clarke [37], enables researchers to extract underlying meanings and patterns from qualitative data, providing a thorough comprehension of the phenomenon being studied.

The interview questions were adapted from the literature review. The comprehensive examination served as a basis for investigating the perspectives of experts in several sectors about supply chain management and sustainability. Significant challenges and strategies were brought to light through insightful discussions, highlighting the opportunities and complexities present in the drive for carbon neutrality.

Table 1: Expert Interviews Thematic Analysis

Profession	Thematic Analysis	Authors
Carbon Auditor	Inability to monitor emissions and ensure compliance to environmental regulations due to a lack of control and visibility throughout the whole supply chain.	Spiller (2021); Touboulic, Matthews, and Marques (2018)
Environmental Consultant	The significance of developing sustainable supply chains and encouraging collaboration among stakeholders to achieve carbon neutrality objectives.	Tokito (2018); Touboulic, Matthews, and Marques (2018)
Consumer Analyst	Companies transitioning to carbon-neutral processes face significant up-front investment costs, which may hinder advancement.	Song et al. (2017); Zhi et al. (2019)
Environmental Engineer	Retailers have to consider the trade-offs associated with achieving carbon neutrality, including holding costs, shipping costs, and carbon emissions costs.	Sarkar et al. (2016); Zhi et al. (2019)
Logistic Personnel	The issue of placing overreliance on secondary data while establishing carbon neutrality objectives and promoting stakeholder collaboration to ensure data reliability	Spiller (2021)
Retail Expert	To achieve carbon neutrality, companies must have the necessary operational and technical capabilities. This suggests interacting with government regulations to assist these companies.	Spiller (2021)
Supply Chain Personnel	The significance of multi-stakeholder collaboration in promoting coordinated efforts towards carbon neutrality, endorsing open lines of communication and strategic partnerships	Olatunji et al. (2019); Zhang et al. (2022a)
Sustainability Manager	The challenges companies encounter in identifying environmentally sensitive sectors within supply chain networks and recommending systematic strategies for sustainable procurement and creative logistics models as solutions	Tokito (2018); Touboulic, Matthews, and Marques (2018)
Producer	Effects of increased operational costs on company efforts to reduce carbon emissions and recommendations for cost-saving measures like reverse logistics and hybrid manufacturing systems	Zhi et al. (2019)
Consumer Analyst	The significance of raising consumer awareness of the importance of carbon neutrality and suggesting ways to use marketing and communication techniques to accomplish this goal.	Lin et al. (2021)

3.2 Survey Questionnaire

The survey's questionnaire offered significant fresh insight into the viewpoints of those involved in manufacturing supply chains who are aware of carbon neutrality. Researchers, business executives, legislators, and environmental specialists were among the respondents, who came from various backgrounds. The Ranking of Relative Importance Index (RII) was utilised through quantitative analysis to rank the most important challenges and strategies. This enabled it to have an in-depth

understanding of the complex issues concerning the achievement of carbon neutrality. The RII was computed using the formula and equation (1).

$$RII = \frac{\sum(W \times N)}{A \times N} \quad (1)$$

Where: *W = Weighting assigned to each Likert scale response (1 to 5)*

N = Total number of responses

A = Maximum weight (5)

3.3 Respondent Background

Table 2 presents the breakdown of respondent backgrounds, providing a visual representation of their diverse expertise.

Table 2: Respondent' Information

	Frequency	Percent
Level of education		
Bachelor's degree	29	43.9
Doctorate	1	1.5
Higher diploma	26	39.4
Master's degree	10	15.2
Job Description		
Carbon Auditor	1	1.5
Environmental Consultant	1	1.5
Consumer Analyst	4	6.1
Environmental Engineer	20	30.3
Logistic Personnel	18	27.3
Retail Expert	1	1.5
Supply Chain Personnel	7	10.6
Sustainability Manager	8	12.1
Producer	1	1.5
Consumer Analyst	5	7.6
Year of experience		
11-15 years	10	15.2
6-10 years	30	45.5
Less than 5 years	26	39.4
Company Size		
1-50 employees	14	21.2
1001+ employees	8	12.1
101-500 employees	12	18.2
501-1000 employee	19	28.8
51-100 employees	13	19.7
Carbon Neutrality Awareness		
No	24	36.4
Yes	42	63.6

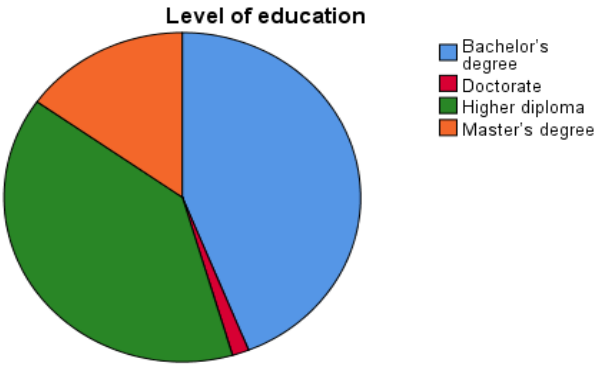

Figure 1: The respondent's Level of Education

The majority hold Bachelor's degrees, comprising 43.9% of the sample, followed by those with Higher Diplomas at 39.4%. Master's degree holders represent 15.2% of respondents, while only 1.5% possess Doctorates.

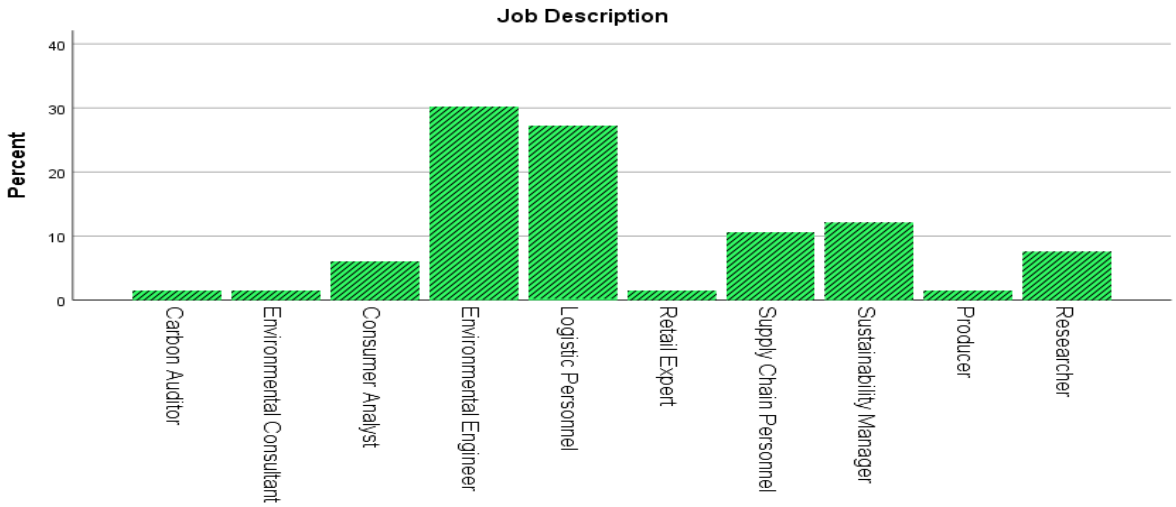

Figure 2**:** The respondent's Job Description

Environmental engineers constitute the largest group, with 20 respondents, representing 30.3% of the total sample. Logistic personnel follow closely behind with 18 respondents, making up 27.3%. Other significant groups include sustainability managers (12.1%), supply chain personnel (10.6%), and consumer analysts (7.6%). Carbon auditors, environmental consultants, retail experts, and producers each represent smaller percentages, with only one respondent each, accounting for 1.5% individually.

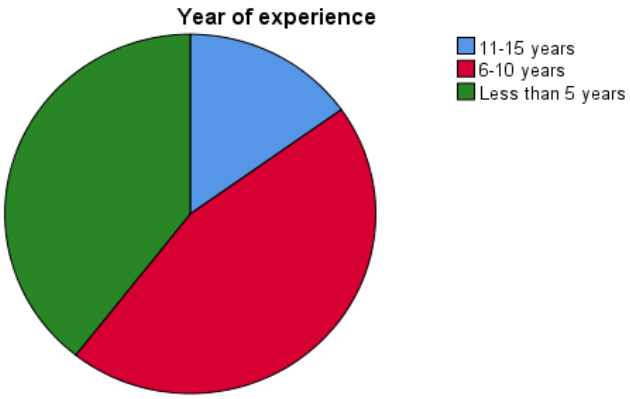

Figure 3: The respondent's Year of Experience

The analysis of respondent experience levels indicates that the majority, comprising 45.5%, have 6-10 years of experience, followed by 39.4% with less than 5 years, and 15.2% with 11-15 years of experience.

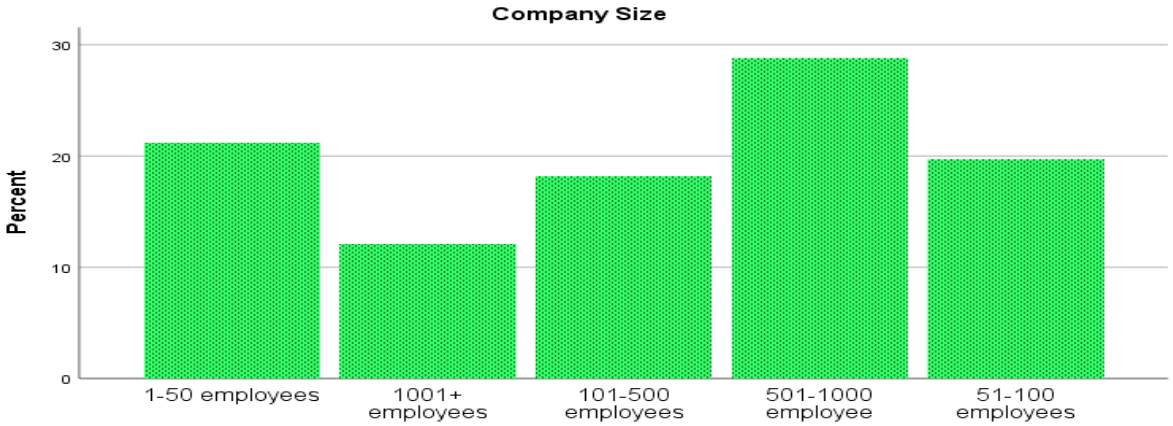

Figure 4: The respondent's Company's size

The analysis reveals that among the respondents, the distribution of company sizes varies. Companies with 501-1000 employees constitute the highest proportion at 28.8%, followed by 1-50 employees at 21.2%, 101-500 employees at 18.2%, 51-100 employees at 19.7%, and 1001+ employees at 12.1%.

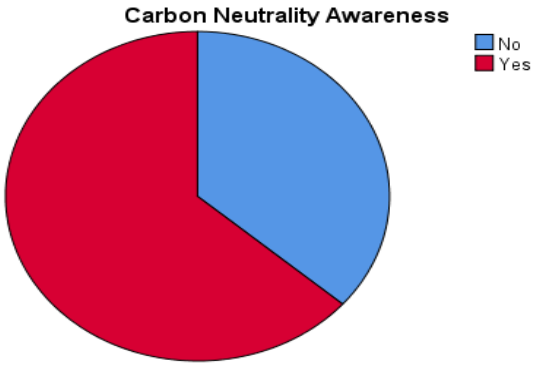

Figure 5: The respondent's Awareness of Carbon Neutrality

The analysis indicates that the majority of respondents, comprising 63.6%, answered "Yes," while 36.4% responded with "No" to the question posed.

3.4 Challenges Relative Importance Index

Table 3: Carbon Neutrality Challenges

Carbon Neutrality Challenges	Total	Total Number (∑W)	A*N	RII	Ranking
Communication and collaboration	319	66	330	0.967	1
Uniformity in accounting and emissions reporting	295	66	330	0.894	2
Control and visibility over the supply chain	288	66	330	0.873	3
Over-reliance on secondary data	284	66	330	0.861	4
Balancing holding costs	272	66	330	0.824	5
Technical know-how	259	66	330	0.785	6
Identifying ecologically sensitive industries	254	66	330	0.770	7
Upfront cost	203	66	330	0.615	8
Customer awareness	196	66	330	0.594	9
Operational costs	169	66	330	0.512	10

The analysis of challenges related to carbon neutrality indicates that different factors have varied priorities and degrees of importance. Based on the Relative Importance Index (RII) and ranking, the most crucial challenge is collaboration and communication, which is ranked in first place with an RII of 0.967. This emphasises how important it is for stakeholders to collaborate and communicate effectively when addressing carbon neutrality challenges. Uniformity in accounting and emissions reporting comes a close second with an RII of 0.894, emphasising the value of standardised procedures in emissions monitoring. With an RII of 0.873, supply chain visibility and control rank third, highlighting the need for enhanced monitoring systems. Other challenges like technical know-how, balancing holding costs, and upfront costs contribute significantly, though with lower RII rankings, Lower rankings for operational costs and customer awareness suggest a less significant influence on the achievement of carbon neutrality. Identifying ecologically sensitive industries is of slight significance ranking sixth among challenges, Overall, the analysis highlights the complexity of the challenges concerning carbon neutrality and how an integrated approach is required to effectively address them.

3.5 Strategies Relative Importance Index

Table 4: Carbon Neutrality Strategies Relative Importance Index

Carbon Neutrality Strategies	Total	Total Number (∑W)	A*N	RII	Ranking
Procurement strategies	319	66	330	0.967	1
Assessing carbon footprint	319	66	330	0.967	1
Carbon management	319	66	330	0.967	1
Reverse logistics	272	66	330	0.824	2
Supply chain coordination	259	66	330	0.785	3

Optimizing carbon emissions	259	66	330	0.785	3
Government regulations	259	66	330	0.785	3
Estimating carbon footprints	203	66	330	0.615	4
Emission quantification	203	66	330	0.615	4
Cap-and-trade system	196	66	330	0.594	5
Sustainable supply chains	196	66	330	0.594	5
Auto-routing system	196	66	330	0.594	5
Collaboration with partners	196	66	330	0.594	5
Renewable energy sources	169	66	330	0.512	6

The ranking and Relative Importance Index (RII) of carbon neutrality strategies reflect various levels of priority and importance. RII of 0.967 for assessing carbon footprint, carbon management, and procurement strategies indicate that these strategies are the most significant ones. The significance of effectively monitoring and regulating carbon emissions across the supply chain is emphasised by these strategies. Reverse logistics is closely behind in second place with an RII of 0.824 is significant for reducing carbon emissions. The third rank, which accounts for supply chain coordination and government regulations with an RII of 0.785, highlights the significance of coordinated efforts and regulatory frameworks to effectively address carbon neutrality. Estimating carbon footprints and emission quantification rank fourth with an RII of 0.615, establishing the significance of these processes for understanding and quantifying carbon emissions. Cap-and-trade, auto-routing systems, sustainable supply chains, and collaboration with partners stood in fifth place with an RII of 0.594. However, renewable energy sources emerged in sixth place with an RII of 0.512, despite having the lowest RII scores. Overall, the analysis highlights how numerous strategies are accessible and how significant it is to take a comprehensive approach to achieve carbon neutrality.

3.6 Discussions

The analysis of survey responses and expert interviews offers insightful data on the strategies and challenges involved in achieving carbon neutrality in supply chain management. To navigate various challenges and encourage collective efforts towards carbon neutrality, both sources emphasise the vital significance of stakeholder collaboration and communication. This is consistent with the survey findings, which showed that experts were unanimous on the significance of communication and collaboration as the top challenge. The expert interviews also clarified industry-specific challenges such as overreliance on secondary data, lack of control and visibility over the supply chain, and high upfront investment costs. These challenges are reflected in the survey results, which supports the findings and highlight how applicable they are to a variety of industries and professions. Similarly, the strategies mentioned by experts, such as carbon management, sustainable supply chains, and procurement strategies closely correspond with those mentioned in the survey. The significance of adopting a comprehensive strategy that covers all facets of supply chain management, from stakeholder engagement to emissions monitoring, is emphasised by both sources. Overall, the analysis shows how opinions on the primary challenges and strategies to achieving carbon neutrality are similar when comparing survey results with expert insights. This uniformity supports the results and highlights the necessity of coordinated efforts among numerous companies and stakeholders to effectively address the complex challenge of carbon emissions in supply chains.

4. Conclusion

In conclusion, the study of strategies and challenges associated with achieving carbon neutrality in manufacturing supply chains highlights the complex nature of this endeavor. Significant insights into the strategies and challenges of carbon neutrality initiatives have been achieved through a mixed-methods approach that combines expert interviews and survey questionnaires. The results emphasise how crucial it is to collaborate, communicate, and use comprehensive carbon management systems to overcome issues like high upfront costs, overreliance on data, and lack of visibility. By prioritising sustainability, developing investments in eco-friendly technologies, and advocating for regulation adherence, stakeholders can overcome these challenges and establish a route towards a more sustainable future. Ultimately, achieving carbon neutrality requires coordinated efforts, creative fixes, and collaborative relationships at every stage of the supply chain. Stakeholders can assist in reducing climate change and promote environmental stewardship in the manufacturing sector by collaborating and implementing strategic initiatives.

4.1 Recommendation

Several key recommendations emerge prominent when considering the strategies and challenges for achieving carbon neutrality in manufacturing supply chains. Firstly, stakeholders need to top priority to improving collaboration and communication at every stage of the supply chain. Through the promotion of open dialogue and strengthening of partnerships, stakeholders may proficiently address challenges and execute carbon neutrality strategies. Secondly, to develop the technical skills required for sustainable practices, it is essential to invest in sustainability education and training. Furthermore, it is critical to implement comprehensive carbon management strategies that incorporate both financial and environmental targets into operational frameworks. Additionally, stakeholders should also proactively encourage advocacy and regulatory compliance to successfully navigate evolving legislative requirements. Lastly, there are opportunities to reduce emissions and improve sustainability through the supply chain by investing in green technologies and innovation. By following these recommendations, stakeholders will be able to navigate the challenges of being carbon-neutral and contribute to a more sustainable future

References

[1] A. Rehman, H. Ma, I. Ozturk, M. Murshed, and V. Dagar, “The dynamic impacts of CO2 emissions from different sources on Pakistan’s economic progress: a roadmap to sustainable development,” *Environ. Dev. Sustain.*, vol. 23, no. 12, pp. 17857–17880, 2021.

[2] C.-C. Lee and F. Wang, “How does digital inclusive finance affect carbon intensity?,” *Econ. Anal. Policy*, vol. 75, pp. 174–190, 2022.

[3] J. Hao, F. Gao, X. Fang, X. Nong, Y. Zhang, and F. Hong, “Multi-factor decomposition and multi-scenario prediction decoupling analysis of China’s carbon emission under dual carbon goal,” *Sci. Total Environ.*, vol. 841, no. 156788, p. 156788, 2022.

[4] E.-Z. Wang and C.-C. Lee, “The impact of commercial bank branch expansion on energy efficiency: Micro evidence from China,” *China Econ. Rev.*, vol. 80, no. 102019, p. 102019, 2023.

[5] J. Hussain and C.-C. Lee, “A green path towards sustainable development: Optimal behavior of the duopoly game model with carbon neutrality instruments,” *Sustain. Dev.*, vol. 30, no. 6, pp. 1523–1541, 2022.

[6] C.-C. Lee, M. Zeng, and K. Luo, “Food security and digital economy in China: A pathway towards sustainable development,” *Econ. Anal. Policy*, vol. 78, pp. 1106–1125, 2023.

[7] T. Xu, C. Kang, and H. Zhang, “China’s efforts towards carbon neutrality: Does energy-saving and emission-reduction policy mitigate carbon emissions?,” *J. Environ. Manage.*, vol. 316, no. 115286, p. 115286, 2022.

[8] S. Zhao, W. Duan, D. Zhao, and Q. Song, “Identifying the influence factors of residents’ low-carbon behavior under the background of ‘Carbon Neutrality’: An empirical study of Qingdao city, China,” *Energy Rep.*, vol. 8, pp. 6876–6886, 2022.

[9] J. T. Houghton, *Global warming: The complete briefing*. Cambridge University Press, 2009.

[10] A. A. King and M. J. Lenox, "Industry self-regulation without sanctions: The chemical industry's responsible care program," *Acad. Manage. J.*, vol. 43, no. 4, pp. 698–716, 2000.

[11] J. Sarkis and Y. Dou, *Green Supply Chain Management: A Concise Introduction*. 1 Edition. | New York : Routledge, 2017.: Routledge, 2017.

[12] Y. Feng, K.-H. Lai, and Q. Zhu, "Green supply chain innovation: Emergence, adoption, and challenges," *Int. J. Prod. Econ.*, vol. 248, no. 108497, p. 108497, 2022.

[13] H. Sun, W. Mao, Y. Dang, and Y. Xu, "Optimum path for overcoming barriers of green construction supply chain management: A grey possibility DEMATEL-NK approach," *Comput. Ind. Eng.*, vol. 164, no. 107833, p. 107833, 2022.

[14] A. Dolgui and J.-M. Proth, *Supply chain engineering: Useful methods and techniques*. London, England: Springer, 2010.

[15] P. Ghosh, A. Jha, and R. R. K. Sharma, "Managing carbon footprint for a sustainable supply chain: a systematic literature review," *Modern Supply Chain Research and Applications*, vol. 2, no. 3, pp. 123–141, 2020.

[16] A. Zhang, M. F. Alvi, Y. Gong, and J. X. Wang, "Overcoming barriers to supply chain decarbonization: Case studies of first movers," *Resour. Conserv. Recycl.*, vol. 186, no. 106536, p. 106536, 2022.

[17] Q. Zhu and Y. Geng, "Drivers and barriers of extended supply chain practices for energy saving and emission reduction among Chinese manufacturers," *J. Clean. Prod.*, vol. 40, pp. 6–12, 2013.

[18] N. Subramanian and M. Abdulrahman, "An examination of drivers and barriers to reducing carbon emissions in China's manufacturing sector," *Int. J. Logist. Manag.*, vol. 28, no. 4, pp. 1168–1195, 2017.

[19] P. Spiller, "Making supply-chain decarbonization happen," *Mckinsey.com*, 14-Jun-2021. [Online]. Available: https://www.mckinsey.com/capabilities/operations/our-insights/making-supply-chain-decarbonization-happen. [Accessed: 06-Apr-2024].

[20] A. Touboulic, L. Matthews, and L. Marques, "On the road to carbon reduction in a food supply network: a complex adaptive systems perspective," *Supply Chain Manage.: Int. J.*, vol. 23, no. 4, pp. 313–335, 2018.

[21] S. Tokito, "Environmentally-targeted sectors and linkages in the global supply-chain complexity of transport equipment," *Ecol. Econ.*, vol. 150, pp. 177–183, 2018.

[22] B. Sarkar, B. Ganguly, M. Sarkar, and S. Pareek, "Effect of variable transportation and carbon emission in a three-echelon supply chain model," *Transp. Res. Part E: Logist. Trans. Rev.*, vol. 91, pp. 112–128, 2016.

[23] B. Zhi, X. Liu, J. Chen, and F. Jia, "Collaborative carbon emission reduction in supply chains: an evolutionary game-theoretic study," *Manag. Decis.*, vol. 57, no. 4, pp. 1087–1107, 2019.

[24] S. Song, K. Govindan, L. Xu, P. Du, and X. Qiao, "Capacity and production planning with carbon emission constraints," *Transp. Res. Part E: Logist. Trans. Rev.*, vol. 97, pp. 132–150, 2017.

[25] J. Lin, R. Fan, X. Tan, and K. Zhu, "Dynamic decision and coordination in a low-carbon supply chain considering the retailer's social preference," *Socioecon. Plann. Sci.*, vol. 77, no. 101010, p. 101010, 2021.

[26] O. O. Olatunji, O. O. Ayo, S. Akinlabi, F. Ishola, N. Madushele, and P. A. Adedeji, "Competitive advantage of carbon efficient supply chain in manufacturing industry," *J. Clean. Prod.*, vol. 238, no. 117937, p. 117937, 2019.

[27] I. Mallidis, D. Vlachos, E. Iakovou, and R. Dekker, "Design and planning for green global supply chains under periodic review replenishment policies," *Transp. Res. Part E: Logist. Trans. Rev.*, vol. 72, pp. 210–235, 2014.

[28] K. Shaw, R. Shankar, S. S. Yadav, and L. S. Thakur, "Modeling a low-carbon garment supply chain," *Prod. Plan. Control*, vol. 24, no. 8–9, pp. 851–865, 2013.

[29] M. García-Alvarado, M. Paquet, and A. Chaabane, "Joint strategic and tactical planning under the dynamics of a cap-and-trade scheme," *IFAC-PapersOnLine*, vol. 49, no. 12, pp. 622–627, 2016.

[30] J. Galve, D. Elduque, C. Pina, and C. Javierre, "Sustainable supply chain management: The influence of disposal scenarios on the environmental impact of a 2400 L waste container," *Sustainability*, vol. 8, no. 6, p. 564, 2016.

[31] M. U. Hossain, A. Sohail, and S. T. Ng, "Developing a GHG-based methodological approach to support the sourcing of sustainable construction materials and products," *Resour. Conserv. Recycl.*, vol. 145, pp. 160–169, 2019.

[32] T. Aljuneidi and A. A. Bulgak, "Carbon footprint for designing reverse logistics network with hybrid manufacturing-remanufacturing systems," *J. Remanufacturing*, vol. 10, no. 2, pp. 107–126, 2020.

[33] G. Zhang, Y. Yang, and G. Yang, "Smart supply chain management in Industry 4.0: the review, research agenda and strategies in North America," *Ann. Oper. Res.*, vol. 322, no. 2, pp. 1075–1117, 2023.

[34] C. H. Glock and T. Kim, "Coordinating a supply chain with a heterogeneous vehicle fleet under greenhouse gas emissions," *Int. J. Logist. Manag.*, vol. 26, no. 3, pp. 494–516, 2015.

[35] C. Blanco, F. Caro, and C. J. Corbett, “An inside perspective on carbon disclosure,” *Bus. Horiz.*, vol. 60, no. 5, pp. 635–646, 2017.

[36] C. Bai, J. Sarkis, and Y. Dou, “Constructing a process model for low-carbon supply chain cooperation practices based on the DEMATEL and the NK model,” *Supply Chain Manage.: Int. J.*, vol. 22, no. 3, pp. 237–257, 2017.

[37] V. Braun and V. Clarke, “Using thematic analysis in psychology,” *Qual. Res. Psychol.*, vol. 3, no. 2, pp. 77–101, 2006.