



Integrating Sustainability into Manufacturing Supply Chains: E-Commerce Adoption and Challenges in Developing Countries

Hieu Vo Minh^{1*} and Ngoc Truong Thi Hue¹

¹ Greenwich University Vietnam, Ho Chi Minh city, Vietnam
HieuVM@fe.edu.vn

Abstract. This study explores how manufacturing firms in developing countries integrate sustainability practices within their supply chains through the adoption of e-commerce platforms. Using two case studies of manufacturing firms in the textile and electronics sectors, this research investigates the motivations, challenges, and strategies involved in the adoption process. Findings indicate that firms are motivated by market differentiation, cost reductions, and the need for environmental compliance. However, they face significant challenges such as limited access to sustainable technologies, financial constraints, and a lack of digital skills within the workforce. To overcome these challenges, firms employ strategies such as external collaboration, staff training, and data-driven decision-making. The study highlights the positive impacts of e-commerce integration on sustainability outcomes, including enhanced operational efficiency, increased market competitiveness, and improved environmental performance. The findings offer valuable insights into the barriers and opportunities for manufacturing firms in developing countries to adopt sustainable practices in their supply chains and provide practical recommendations for overcoming these challenges.

Keywords: Sustainability Practices, E-Commerce Integration, Supply Chain Management, Developing Countries, Green Supply Chain Management, Digital Transformation, Manufacturing Firms, Circular Economy, Operational Efficiency, Supply Chain Challenges.

1 Introduction

Sustainability has become a critical focus for businesses globally, with manufacturing firms at the forefront of adopting sustainable practices within their supply chains. The growing concerns about climate change, resource depletion, and environmental degradation have prompted organizations to re-evaluate their operations, particularly the environmental impact of their supply chains. In response, companies have been increasingly integrating sustainability into their supply chain management practices, aiming to reduce their carbon footprint, source materials ethically, and promote environmental stewardship throughout their value chains. Despite the recognized importance of sustainable practices, the adoption and implementation of such strategies remain complex,

especially for manufacturing firms operating in developing countries (Alzubi & Akkerman, 2022).

In developing economies, manufacturing firms face unique challenges when it comes to implementing sustainability practices within their supply chains. These challenges include limited access to sustainable technologies, financial constraints, inadequate regulatory frameworks, and weak infrastructure, all of which can hinder efforts to adopt and scale sustainability initiatives (Kshetri, 2021). Moreover, the integration of sustainability into supply chains requires firms to manage a complex set of factors, including environmental impacts, social equity, and economic viability, which are often at odds with the pressures of maintaining cost efficiency and meeting market demands (Sharma et al., 2022). These barriers are particularly pronounced in developing countries, where manufacturing industries are crucial to economic growth but are also significant contributors to environmental degradation (Antwi, Agyapong, & Owusu, 2022). For example, firms operating in such environments must balance the need for economic growth with the imperative to adopt sustainable practices, an often-difficult task in the absence of robust support systems and infrastructure (Sahoo & Vijayvargy, 2021).

The motivation for this research stems from the need to better understand the ways in which manufacturing firms in developing countries can successfully integrate sustainability practices into their supply chains. While there is a growing body of literature on sustainability in supply chains, there remains a limited focus on the specific challenges and opportunities faced by firms in developing countries (Alzubi & Akkerman, 2022). This study seeks to fill this gap by exploring the sustainable supply chain practices of a manufacturing firm operating in a developing economy. By examining how the firm addresses the complexities of sustainability integration, the research aims to provide insights into the barriers that hinder sustainability adoption and the strategies that can be employed to overcome them (Khan et al., 2021).

The purpose of this study is to investigate how manufacturing firms in developing countries implement sustainability practices within their supply chains and to assess the challenges they encounter in the process. By examining a specific case study, the research will offer a nuanced understanding of the sustainable practices being adopted, the obstacles faced, and the benefits realized by the firm. This research will contribute to the broader discourse on sustainability in global supply chains, with a particular emphasis on the unique context of developing countries (Ngo et al., 2024). The central research question guiding this study is: How do manufacturing firms in developing countries implement sustainability practices within their supply chains, and what are the key challenges they face in the process?

This question will be explored through an in-depth case study of a manufacturing firm known for its environmental sustainability initiatives, with a focus on understanding the factors influencing the adoption of sustainable practices and the challenges that hinder their effective implementation (Georgise, Thoben, & Seifert, 2014).

2 Literature review

This section reviews the literature on the integration of sustainability practices within the supply chains of manufacturing firms, with a specific focus on firms in developing countries. Sustainable supply chain management (SSCM) is crucial for firms in these regions, where environmental concerns, economic limitations, and regulatory challenges intersect. The review is organized into two main subsections: (1) sustainability practices in manufacturing firms, and (2) the specific challenges and opportunities faced by manufacturing firms in developing countries in adopting these practices.

Sustainability in supply chains has become increasingly important for manufacturing firms globally, particularly as the environmental impacts of industrial production come under scrutiny. Green supply chain management (GSCM) is one of the central approaches in integrating sustainability into supply chain operations. GSCM practices involve the reduction of waste, efficient energy use, and ethical sourcing of raw materials. According to Sahoo and Vijayvargy (2021), many manufacturing firms that adopt green supply chain practices experience enhanced organizational performance due to cost savings, regulatory compliance, and improved stakeholder relations.

Manufacturing firms, particularly in industries such as textiles, food, and electronics, have implemented low-carbon practices within their supply chains. These practices include minimizing energy use in manufacturing, reducing emissions, and optimizing logistics to reduce transportation costs and fuel consumption. Sharma et al. (2022) argue that environmental dynamism, such as shifts in consumer preferences toward more sustainable products, has led to the increased adoption of low-carbon practices within supply chains in developing countries. This is important, as manufacturing firms must balance the need for efficiency with environmental responsibility to maintain competitiveness in both local and global markets.

Furthermore, manufacturing firms are increasingly investing in the adoption of ethical sourcing practices. This involves ensuring that raw materials are sourced in ways that do not harm the environment or local communities. Alzubi and Akkerman (2022) found that manufacturing companies in Jordan have made significant strides in ethical sourcing, emphasizing the role of transparency and traceability in their supply chains. This practice is particularly crucial in industries that rely on scarce or natural resources, where unsustainable practices can lead to long-term environmental damage and reputational risk.

In addition, the integration of circular economy principles is becoming a prominent sustainable practice within manufacturing firms' supply chains. The transition from a linear to a circular economy, as discussed by Sharma et al. (2022), focuses on recycling, reusing, and reducing materials used in manufacturing processes. This practice helps to minimize waste, reduce resource consumption, and improve the overall sustainability of the supply chain.

Manufacturing firms in developing countries face several unique challenges when integrating sustainability practices within their supply chains. One of the most significant obstacles is the limited access to sustainable technologies and practices. Many developing countries lack the infrastructure and financial resources needed to implement advanced green technologies, such as energy-efficient machinery, waste

management systems, or renewable energy sources. Antwi, Agyapong, and Owusu (2022) highlight that mining firms in developing countries, for instance, struggle to implement sustainable practices due to the high cost of adopting new technologies, which is exacerbated by the economic conditions in these regions.

Another challenge is the lack of regulatory frameworks or the enforcement of existing environmental regulations. In many developing countries, regulatory structures are either absent or insufficiently developed to support sustainable supply chain management effectively. Kshetri (2021) argues that the absence of clear and enforceable regulations can undermine firms' incentives to invest in sustainability practices, especially when the cost of such investments is high. In contrast, when governments introduce regulations that mandate sustainable practices, firms are more likely to adopt these practices, even in the face of financial and technological barriers.

Despite these challenges, there are opportunities for manufacturing firms in developing countries to enhance the sustainability of their supply chains. One such opportunity is the increasing global demand for environmentally friendly products, which offers firms a competitive advantage in international markets. Khan et al. (2021) argue that firms in developing countries can leverage green data analytics and blockchain technology to improve transparency and traceability in their supply chains. These technologies can help firms ensure that their products meet international sustainability standards and provide evidence of their commitment to sustainable practices.

Moreover, the growing consumer awareness of environmental and social issues presents a significant opportunity for firms to adopt sustainable practices in response to market demands. Sahoo and Vijayvargy (2021) suggest that manufacturers who adopt green practices can differentiate themselves from competitors by marketing their sustainability efforts, which can attract environmentally conscious consumers. Additionally, firms that adopt circular economy principles can not only reduce their environmental footprint but also unlock new business models that promote resource efficiency and waste reduction.

Finally, collaboration with global supply chain partners presents an opportunity for firms in developing countries to access resources, knowledge, and technologies that may otherwise be unavailable to them. Partnerships with international organizations, NGOs, and multinational corporations can help local firms implement sustainability practices by providing access to funding, technical expertise, and markets. This collaboration is particularly beneficial for small and medium-sized enterprises (SMEs) in developing countries, which often lack the resources to undertake large-scale sustainability initiatives independently (Alzubi & Akkerman, 2022).

In summary, manufacturing firms in developing countries are increasingly adopting sustainability practices within their supply chains as part of a global trend toward environmental responsibility. These practices, including green supply chain management, ethical sourcing, and the adoption of circular economy principles, offer significant opportunities for firms to improve their operational efficiency, reduce costs, and enhance competitiveness (Song et al., 2021). However, these firms face substantial challenges, including limited access to sustainable technologies, financial constraints, and the lack of robust regulatory frameworks. Nevertheless, there are clear

opportunities for overcoming these challenges, particularly through the adoption of emerging technologies such as blockchain and green data analytics, as well as through strategic partnerships with international organizations. This literature review highlights the need for further research into the specific strategies and frameworks that can facilitate the successful implementation of sustainability practices within manufacturing firms' supply chains in developing countries.

3 Methodology

This research adopts a multiple-case study design to explore how manufacturing firms in developing countries implement sustainability practices within their supply chains through the integration of e-commerce platforms. The study focuses on two cases of manufacturing firms that have adopted e-commerce platforms to enhance their sustainability efforts. This approach provides a comparative perspective that helps identify the common strategies, challenges, and benefits these firms encounter during the process of integrating sustainability into their supply chain operations. The research design is centered around a qualitative approach, which allows for a deep exploration of the complexities involved in implementing sustainability practices within the supply chains of manufacturing firms in developing countries. The case study method is particularly suited for this research as it facilitates an in-depth understanding of the processes, practices, and experiences of firms adopting e-commerce platforms to enhance sustainability.

The study focuses on two manufacturing firms, one in the textile industry and the other in the electronics sector, both operating in developing countries. These firms were selected based on their demonstrated efforts to integrate sustainability into their supply chain management practices through the use of e-commerce technologies. Each of the chosen firms has taken significant steps to reduce their environmental impact and improve social equity in their supply chain operations, making them ideal candidates for the case study. By examining these cases, the research provides valuable insights into how e-commerce platforms are being used to implement green supply chain practices and the challenges these firms face in doing so.

The setting of the research within developing countries is particularly significant, as manufacturing firms in these regions face unique constraints and opportunities in adopting sustainability practices. These include limited financial resources, inadequate technological infrastructure, and weaker regulatory frameworks, which often hinder the effective integration of sustainable practices (Alzubi & Akkerman, 2022). However, these firms also face significant market pressure to adopt sustainable practices due to growing global awareness and consumer demand for ethically produced goods.

The primary data for this study were collected through semi-structured interviews, which provide a flexible yet structured approach to gathering qualitative data. Semi-structured interviews are particularly useful in case study research as they allow for an in-depth exploration of complex topics while still maintaining focus on key research questions. In this study, the semi-structured interviews were designed to capture the experiences, challenges, and strategies employed by the key decision-makers involved

in the adoption and integration of e-commerce platforms in the supply chains of the two selected manufacturing firms. Participants were selected based on their roles and direct involvement in the e-commerce adoption process. This included senior management, supply chain managers, and IT staff responsible for the integration of e-commerce technologies into supply chain operations. The interviews aimed to explore the following key areas: (1) The motivations for integrating e-commerce platforms to enhance sustainability practices in the supply chain. (2) The challenges faced during the adoption and integration of e-commerce technologies. (3) The strategies used by the firms to overcome these challenges. (4) The perceived benefits of integrating sustainability into supply chain management through e-commerce.

The interviews were conducted either in person or via online platforms, depending on the preferences and availability of the participants. All interviews were audio-recorded with the consent of the participants and subsequently transcribed for analysis. The interview protocol was designed to be flexible, allowing participants to discuss their experiences in their own words while ensuring that the conversation remained relevant to the research objectives.

The data collected from the semi-structured interviews were analyzed using thematic analysis and content analysis, two widely used methods for qualitative data interpretation. Thematic analysis allows for the identification of patterns or themes within the data, providing insights into the underlying issues and practices related to the adoption of e-commerce for sustainability in supply chains. The process began with a thorough familiarization with the data, followed by the generation of initial codes that captured key concepts related to sustainability practices, e-commerce integration, and the challenges encountered.

These codes were then grouped into broader themes, which were further refined to ensure they accurately reflected the data and the research objectives. The themes were organized into categories such as "barriers to sustainability adoption," "strategies for overcoming challenges," and "outcomes of integrating e-commerce with sustainability efforts." This approach allowed for an in-depth exploration of how the firms navigated the complexities of sustainability integration and the role of e-commerce in facilitating these efforts. In addition to thematic analysis, content analysis was used to quantify the occurrence of specific terms, concepts, and phrases within the interview data. Content analysis provides a systematic approach to identifying trends and patterns in qualitative data, allowing the researcher to assess the frequency and emphasis of particular themes, such as "technology integration," "financial constraints," and "regulatory compliance." By combining thematic and content analysis, the study was able to provide both a qualitative and quantitative understanding of the sustainability practices adopted by the manufacturing firms and the role of e-commerce platforms in facilitating these practices.

To ensure the validity and reliability of the findings, data triangulation was employed. In addition to the semi-structured interviews, secondary data sources such as company reports, sustainability performance records, and e-commerce platform usage data were reviewed. This secondary data provided additional context and supported the findings from the interviews, helping to verify the accuracy and consistency of the reported practices and challenges. Triangulation of both primary and secondary data

sources strengthened the overall robustness of the research and helped mitigate any biases inherent in the data collection process.

4 Findings

The findings from this study provide a comprehensive understanding of how manufacturing firms in developing countries integrate sustainability practices into their supply chains through the adoption of e-commerce platforms. The data collected from the semi-structured interviews with key decision-makers in two manufacturing firms revealed important insights into the motivations, challenges, strategies, and outcomes of sustainability integration. The findings are presented under four key themes: motivations for adopting sustainability practices, challenges encountered during integration, strategies for overcoming challenges, and the impacts of e-commerce integration on sustainability efforts.

4.1 Motivations for Adopting Sustainability Practices

Both manufacturing firms identified market differentiation and cost reduction as primary motivations for integrating sustainability into their supply chains through e-commerce. The textile firm emphasized that customer demand for sustainable products had significantly increased over the years, especially from international markets that required evidence of ethical sourcing and environmental responsibility. The firm's manager explained, "We recognized early on that our customers were increasingly concerned about sustainability. If we wanted to stay competitive, we had to adapt our operations to meet their expectations." This response reflects the growing trend of consumer demand for sustainable products, which has driven many manufacturing firms in developing countries to adopt green practices (Sahoo & Vijayvargy, 2021).

Similarly, the electronics manufacturing firm highlighted cost savings as a major motivator for adopting e-commerce platforms to manage their supply chain sustainability efforts. By reducing the need for physical stores, streamlining logistics, and optimizing energy usage in production, the firm was able to cut operational costs significantly. The supply chain manager from the electronics firm stated, "The savings we made by eliminating inefficient manual processes and reducing waste in our supply chain were reinvested into more sustainable technologies, like energy-efficient machinery." This is consistent with findings from Alzubi and Akkerman (2022), who argue that adopting sustainability practices not only enhances market competitiveness but also leads to long-term operational cost reductions.

4.2 Challenges Encountered During E-Commerce Adoption

The implementation of e-commerce platforms to support sustainability practices was not without its challenges. A common theme across both cases was the lack of technological infrastructure and limited financial resources to support the full integration of

e-commerce systems. In the textile firm, the manager discussed the difficulty of selecting and implementing an e-commerce platform that could accommodate the company's complex supply chain requirements. He explained, "We were limited by both our technological capacity and our budget. Selecting a platform that was both affordable and capable of handling our needs was a huge challenge."

Similarly, the electronics firm faced difficulties in integrating e-commerce with existing supply chain management systems. The integration required significant technological upgrades, which were costly and time-consuming. The firm's IT manager shared, "We had to make substantial investments in our IT infrastructure to ensure that the e-commerce platform was compatible with our existing systems. The costs associated with upgrading our technology were far higher than we had initially anticipated." Both firms also encountered challenges related to digital skills gaps within their workforce. In the textile firm, employees lacked experience with e-commerce tools and digital marketing techniques, which initially hindered the firm's ability to fully utilize the platform. The HR manager of the textile firm noted, "Our staff were unfamiliar with e-commerce platforms and digital tools. We had to invest in training programs, but even then, the learning curve was steep." This finding is consistent with the work of Khan et al. (2021), who highlight that digital literacy and skills gaps often hinder the successful adoption of technology-driven sustainability practices in developing countries.

4.3 Strategies Adopted to Overcome Difficulties

Staff training was a key strategy employed by the textile firm. In response to the lack of digital skills, the firm invested in internal training programs and hired external consultants to provide e-commerce and digital marketing expertise. The textile firm's manager explained, "We recognized the importance of upskilling our workforce to make the most of our e-commerce platform. Without the right knowledge, we could not expect to reap the benefits of the system."

For the electronics firm, external collaboration was a critical strategy to overcome the technological barriers they faced. The firm partnered with a technology provider to integrate the e-commerce platform with their existing supply chain management system. The firm's IT manager explained, "We realized we needed external expertise to ensure that the integration process was smooth and successful. Partnering with a technology provider who understood both e-commerce and supply chain management was essential." This approach mirrors the findings of Kshetri (2021), who discusses how partnerships with external vendors can help overcome technological limitations, especially in developing countries.

Additionally, both firms utilized data-driven decision-making to optimize their supply chain operations and enhance their sustainability efforts. The textile firm, for instance, used customer data collected from the e-commerce platform to understand consumer preferences and optimize their inventory. The manager stated, "We now use customer feedback from our e-commerce platform to better manage our stock and reduce waste. This has helped us make more sustainable decisions about which products to keep in our inventory." The electronics firm similarly used data analytics to reduce

energy consumption in production and streamline logistics. The supply chain manager noted, "With the help of analytics, we were able to optimize our supply chain and reduce our carbon footprint, ultimately lowering costs and improving our sustainability performance."

4.4 Impacts of E-Commerce Integration on Sustainability Practices

Both manufacturing firms experienced positive impacts as a result of integrating e-commerce platforms into their supply chain sustainability practices. The textile firm reported a significant increase in sales following the adoption of the e-commerce platform. By reaching a wider customer base and offering transparent information about sustainable sourcing, the firm was able to appeal to environmentally conscious consumers. The business owner stated, "We have seen our sales grow, particularly among customers who value sustainability. Our e-commerce platform has allowed us to market our green initiatives effectively."

The electronics firm also observed improvements in operational efficiency. The firm reported that the integration of e-commerce not only streamlined procurement processes but also helped optimize energy usage in production. The firm's sustainability officer remarked, "By digitizing our operations and integrating e-commerce, we've seen a reduction in our energy consumption and overall waste, leading to improved sustainability performance across our supply chain." This finding aligns with the research by Sharma et al. (2022), which highlights how digital technologies, including e-commerce platforms, can enhance the sustainability performance of firms by improving efficiency and reducing waste. Furthermore, both firms noted the enhanced competitiveness resulting from the integration of e-commerce. The textile firm gained a competitive advantage by catering to a growing market of eco-conscious consumers, while the electronics firm strengthened its market position by promoting its environmental sustainability efforts through e-commerce. The supply chain manager from the electronics firm explained, "We've managed to position ourselves as a more sustainable company, which has enhanced our reputation and given us a competitive edge in both local and international markets."

The findings from the interviews demonstrate that the integration of e-commerce platforms into manufacturing supply chains in developing countries can have a significant positive impact on sustainability practices. The motivations for adopting e-commerce include market expansion, cost reduction, and improving operational efficiency. However, manufacturing firms face several challenges during the integration process, including technological limitations, financial constraints, and digital skills gaps. To overcome these challenges, firms adopt strategies such as staff training, external collaboration, and data-driven decision-making. The integration of e-commerce platforms results in improved sustainability outcomes, including increased sales, enhanced operational efficiency, and greater competitiveness in the market. These findings provide valuable insights for manufacturing firms in developing countries seeking to integrate sustainability into their supply chains through digital transformation.

5 Discussion

This section addresses the main research question: How do manufacturing firms in developing countries implement sustainability practices within their supply chains, and what are the key challenges they face in the process? Drawing from the findings of the case studies and supported by the relevant literature, this discussion explores the strategies employed by manufacturing firms in developing countries to integrate sustainability practices into their supply chains, the challenges they face, and the opportunities for overcoming these barriers. The findings are framed within the context of the broader discourse on sustainable supply chain management (SSCM) in developing economies.

5.1 Implementation of Sustainability Practices in Manufacturing Supply Chains

The research revealed that manufacturing firms in developing countries implement a variety of sustainability practices within their supply chains, driven primarily by the need for market differentiation, cost reductions, and compliance with environmental regulations. These firms, much like those studied by Antwi, Agyapong, and Owusu (2022), adopt green supply chain management (GSCM) practices to reduce their environmental impact and improve their sustainability performance. For example, the textile firm in the case study integrated practices such as reducing carbon emissions and ethical sourcing of raw materials, which are central to GSCM. These practices align with the findings of Alzubi and Akkerman (2022), who observed that manufacturing companies in Jordan were increasingly focusing on minimizing the carbon footprint and improving environmental performance as part of their sustainability strategies.

Moreover, the study highlights the growing importance of low-carbon practices, which have become integral to the sustainability strategies of firms in developing countries. As Sharma et al. (2022) note, low-carbon practices, particularly in industries like textiles and electronics, are essential in responding to the demands of environmental dynamism, such as climate change and regulatory pressures. The electronics firm in the case study, for instance, implemented energy-efficient production processes and optimized its logistics to reduce emissions. This practice mirrors Sahoo and Vijayvargy's (2021) findings, which indicate that low-carbon practices can lead to improvements in organizational performance and reduced operational costs, offering a compelling reason for firms in developing countries to adopt such practices.

In addition to reducing carbon emissions, manufacturing firms are increasingly adopting circular economy principles within their supply chains. Circularity, which involves reducing waste, reusing materials, and recycling, is becoming an important part of sustainability strategies in developing countries. The findings from Sharma et al. (2022) on manufacturers' transitions from linear to circular economies reflect the shift in the manufacturing sector towards adopting circular supply chain practices. In this study, both firms made efforts to reduce waste in their production processes and sought to optimize the use of resources, thus enhancing their environmental sustainability.

5.2 Challenges Faced in the Implementation of Sustainability Practices

Despite the clear benefits of adopting sustainability practices, manufacturing firms in developing countries face significant challenges in integrating these practices into their supply chains. A central challenge identified in the research is limited access to sustainable technologies, which is a barrier to implementing green supply chain practices. Both case firms struggled with the high costs and technical requirements of adopting new technologies that support sustainability efforts. As Kshetri (2021) notes, the lack of technological infrastructure and the high costs of green technologies in developing countries are significant barriers to the successful integration of sustainability practices. This was particularly evident in the electronics firm, where substantial investments in energy-efficient machinery and IT infrastructure were necessary to align the supply chain with sustainability goals.

Another critical challenge faced by the firms was financial constraints. Developing countries often have limited access to capital, making it difficult for firms to invest in sustainable practices, which typically require significant upfront costs. This financial barrier is consistent with the findings of Antwi, Agyapong, and Owusu (2022), who discuss how mining firms in developing countries face similar financial constraints when adopting green supply chain practices. In the case study firms, the textile firm, for example, struggled to secure adequate funding to implement energy-efficient systems and expand its sustainability initiatives. This challenge is further compounded by limited financial support from governmental institutions, which often lack the resources or political will to assist firms in their sustainability efforts (Georgise, Thoben, & Seifert, 2014).

In addition to financial barriers, the firms also encountered regulatory challenges. The regulatory frameworks in many developing countries are often inadequate or poorly enforced, making it difficult for firms to comply with environmental standards. The electronics firm, for example, found that while they were aware of global sustainability standards, the local regulatory environment provided limited incentives or penalties for adopting such practices. This aligns with the research of Kshetri (2021), who highlights that weak regulatory frameworks in developing countries often undermine efforts to implement sustainable supply chain practices, as firms are not sufficiently incentivized or required to comply with sustainability standards.

Furthermore, cultural and organizational resistance to change emerged as a barrier to sustainability adoption. As highlighted by Alzubi and Akkerman (2022), manufacturing firms in developing countries often prioritize short-term cost savings over long-term sustainability goals, which hinders the willingness of management and employees to embrace green practices. In the case study firms, there was resistance from certain employees who were accustomed to traditional, cost-focused production methods. This resistance to change can delay the implementation of sustainability practices, as firms struggle to reconcile the need for innovation with existing business processes.

5.3 Overcoming the Challenges and Opportunities for Implementation

While the challenges identified in this study are significant, both case study firms employed various strategies to overcome these barriers. External collaboration played a

key role in addressing technological and financial constraints. For the textile firm, collaboration with international partners who specialized in sustainable technologies allowed the firm to access new machinery and energy-efficient systems. Similarly, the electronics firm partnered with external consultants to help integrate e-commerce platforms with their existing supply chain systems. This approach mirrors the findings of Khan et al. (2021), who emphasize the role of external collaborations in enabling SMEs in developing countries to adopt sustainable practices through access to resources, knowledge, and financing.

Staff training was another critical strategy employed by the case study firms to overcome the digital skills gap. Both firms invested in training programs to upskill their workforce and ensure that employees could effectively manage e-commerce platforms and sustainability initiatives. This finding supports Sahoo and Vijayvargy (2021), who argue that investing in human capital is essential for successfully implementing green supply chain practices in developing countries, particularly when new technologies and processes are involved.

Furthermore, both firms utilized data analytics to improve sustainability performance in their supply chains. The electronics firm used data analytics to track energy consumption and optimize production processes, while the textile firm used data to manage inventory more sustainably and reduce waste. As Sharma et al. (2022) note, the use of data-driven decision-making plays a key role in enhancing the effectiveness of sustainability practices by enabling firms to identify inefficiencies and make more informed decisions

6 Conclusion

This study investigates how manufacturing firms in developing countries implement sustainability practices within their supply chains, with a focus on the challenges they face and the strategies they employ to overcome these barriers. The research draws upon two case studies of manufacturing firms that have integrated e-commerce platforms to enhance their sustainability practices. The findings provide significant insights into the adoption process, the key factors influencing sustainability practices, and the outcomes of integrating e-commerce for supply chain management. The study also discusses the implications of these findings for both theory and practice, offering valuable contributions to the field of sustainable supply chain management in developing countries.

6.1 Theoretical Contribution

The theoretical contribution of this research lies in extending the existing literature on sustainable supply chain management (SSCM), particularly within the context of developing countries. While much of the previous research on GSCM and sustainability practices has focused on developed economies, there is a gap in understanding the specific challenges and strategies faced by firms in developing countries (Alzubi & Ak-

kerman, 2022; Antwi, Agyapong, & Owusu, 2022). This study adds depth to the literature by exploring how manufacturing firms in developing economies integrate sustainability practices into their supply chains, despite the financial, technological, and regulatory barriers they face.

One of the key theoretical contributions of this study is the identification of external collaboration as a crucial strategy for overcoming the technological and financial challenges of sustainability adoption. The research shows that collaborations with international partners, NGOs, and technology providers can help firms in developing countries access the resources and expertise required to implement sustainable practices (Kshetri, 2021; Khan et al., 2021). This finding expands on the work of Sahoo and Vijayvargy (2021), who suggest that external collaborations are essential for overcoming the barriers to green supply chain adoption in developing economies.

Additionally, this study contributes to the growing body of literature on data-driven decision-making and its role in enhancing sustainability practices. The use of data analytics to optimize supply chain operations and improve sustainability outcomes, as observed in both case firms, highlights the importance of technological innovation in driving sustainable practices. This finding is consistent with the work of Sharma et al. (2022), who emphasize that digital technologies, including data analytics, can significantly enhance the sustainability performance of manufacturing firms.

Furthermore, the research contributes to the understanding of circular economy principles in the context of developing countries, providing evidence that even in resource-constrained environments, firms can adopt circular practices such as waste reduction and resource optimization (Binh et al., 2025). This aligns with the findings of Ishaq et al. (2025), who discuss how firms are transitioning from linear to circular economies, improving their sustainability performance while also unlocking new business opportunities.

6.2 Practical Contributions

This study provides actionable insights for manufacturing firms in developing countries seeking to integrate sustainability practices into their supply chains. The findings emphasize the importance of strategic planning and investment in technology to overcome the barriers to sustainability adoption. Manufacturing firms in developing countries must prioritize sustainability as a core component of their long-term business strategies, recognizing that the integration of green practices can not only reduce environmental impact but also lead to improved efficiency, cost savings, and enhanced competitiveness.

The study highlights staff training as an essential strategy for addressing the digital skills gap within firms. Given that many employees in developing countries lack the expertise needed to operate e-commerce platforms and manage sustainability data, firms must invest in capacity-building initiatives. This includes both technical training in e-commerce systems and broader sustainability education, which will enable firms to fully realize the potential of digital technologies in enhancing supply chain sustainability.

Moreover, the findings underscore the importance of external collaboration in facilitating the adoption of sustainable practices. Manufacturing firms can benefit from partnerships with international organizations, government bodies, and technology providers, which can offer technical assistance, funding, and access to global markets. By collaborating with stakeholders across the supply chain, firms can overcome financial and technological constraints, improving both their environmental and economic performance.

Finally, the study calls for policy support from governments and international organizations to facilitate the adoption of sustainable practices in manufacturing supply chains. Policymakers can play a crucial role by creating favorable regulatory environments, providing financial incentives, and supporting research and development in sustainable technologies. Strong government support is essential to incentivize sustainability efforts, especially in developing countries where firms often face substantial financial and regulatory challenges.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

References

1. Alzubi, E., & Akkerman, R.: Sustainable supply chain management practices in developing countries: An empirical study of Jordanian manufacturing companies. *Cleaner production letters*, 2, 100005 (2022)
2. Antwi, B. O., Agyapong, D., & Owusu, D.: Green supply chain practices and sustainable performance of mining firms: Evidence from a developing country. *Cleaner Logistics and Supply Chain*, 4, 100046 (2022).
3. Binh, A. D. T., Duc, T. T., Nguyen, H., Hoang, T. G., Quang, H. T., & Akbari, M.: Strategic insights into geosustainable Excellence: Unveiling a Resource-Based dynamic approach in global food supply chains for carbon neutrality and economic performance. *Gondwana Research* (2025).
4. Georgise, F. B., Thoben, K. D., & Seifert, M.: Supply chain integration in the manufacturing firms in developing country: An Ethiopian case study. *Journal of Industrial Engineering*, 2014(1), 251982 (2014).
5. Ishaq, S., Tanveer, U., Hoang, T. G., & Wamba Samuel, F.: From Linear to Circular: Capabilities, Defensive Reasoning and Supply Chain Collaborations in Manufacturers' Circular Economy Transition. *British Journal of Management* (2025).
6. Khan, S. A. R., Godil, D. I., Jabbour, C. J. C., Shujaat, S., Razzaq, A., & Yu, Z.: Green data analytics, blockchain technology for sustainable development, and sustainable supply chain practices: evidence from small and medium enterprises. *Annals of Operations Research*, 1-25 (2021).
7. Kshetri, N.: Blockchain and sustainable supply chain management in developing countries. *International Journal of Information Management*, 60, 102376 (2021).

8. Ngo, V. M., Quang, H. T., Hoang, T. G., & Binh, A. D. T.: Sustainability-related supply chain risks and supply chain performances: The moderating effects of dynamic supply chain management practices. *Business Strategy and the Environment*, 33(2), 839-857 (2024).
9. Sahoo, S., & Vijayvargy, L.: Green supply chain management practices and its impact on organizational performance: evidence from Indian manufacturers. *Journal of Manufacturing Technology Management*, 32(4), 862-886 (2021).
10. Sharma, M., Kumar, A., Luthra, S., Joshi, S., & Upadhyay, A.: The impact of environmental dynamism on low-carbon practices and digital supply chain networks to enhance sustainable performance: An empirical analysis. *Business Strategy and the Environment*, 31(4), 1776-1788 (2022).
11. Song, H., Li, M., & Yu, K.: Big data analytics in digital platforms: how do financial service providers customise supply chain finance?. *International Journal of Operations & Production Management*, 41(4), 410-435 (2021).

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

