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GREEN MANUFACTURING STRATEGY AS A PILLAR OF SUSTAINABLE INNOVATION: A SWOT ANALYSIS

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ABSTRACT

Objectives: This research aims to examine the role of green manufacturing strategies as a key pillar in driving sustainable innovation in the Industry 4.0 era, focusing on how the integration of green practices can improve competitiveness, operational efficiency, and environmental sustainability in the manufacturing sector.

Research Design & Methods: This study uses a SWOT analysis approach to evaluate the strengths, weaknesses, opportunities and threats faced by companies in implementing green manufacturing strategies. This method helps identify internal and external factors that influence the effectiveness of green manufacturing adoption in the context of modern industrial transformation.

Findings: The results show that green manufacturing strengthens sustainable innovation through waste reduction, energy efficiency, and resource optimization. The integration of Industry 4.0 technologies such as Manufacturing Execution Systems (MES), Industrial Internet of Things (IIoT), and Additive Manufacturing supports the achievement of sustainability goals while improving product competitiveness in the global market.

Implications & Recommendations: Companies need to strengthen cross-functional collaboration, develop internal capacity to absorb green innovations, and invest in Industry 4.0-based technologies to optimize green manufacturing practices. In addition, a comprehensive SWOT analysis is recommended as a strategic tool to design sustainable innovations that are more adaptive to market dynamics and changing environmental regulations.

Contribution & Value Added: This research makes theoretical and practical contributions by offering an integrated SWOT-based analytical framework to drive the implementation of green manufacturing as a sustainable innovation strategy. This study also enriches the literature by linking Industry 4.0 dynamics with sustainability practices in modern manufacturing.

Keywords: Green Manufacturing, Sustainable Innovation, Environmental Sustainability

JEL codes: L60, M11, Q01

Article type: research paper

INTRODUCTION

Green manufacturing has emerged as a key strategy in facing the major challenges of the 21st century, especially in balancing industrial growth with the increasingly crucial demands of environmental sustainability. Amidst growing concerns about the global climate crisis, conventional manufacturing practices are known to contribute significantly to environmental degradation through excessive waste in solid, liquid, and gaseous forms, which are often not managed sustainably. The sector also contributes to high greenhouse gas emissions. And the overconsumption of energy and natural resources such as water, metals and other raw materials is intensive and often without regard for environmental sustainability (Haleem et al., 2023). Traditional production systems oriented towards short-term efficiency often ignore long-term ecological impacts, accelerating environmental degradation, and exacerbating climate change.

This situation emphasizes the importance of industrial transformation towards more sustainable production methods.

In this context, green manufacturing offers solutions with a cleaner and more efficient approach, and emphasizes the principles of recycling, waste reduction, and energy efficiency throughout the product life cycle, from the design stage to the end of life (Huang & Zhu, 2014). This concept not only focuses on reducing the environmental impact of manufacturing activities but also promotes economic sustainability by improving efficiency in resource utilization. For example, the application of recycled materials and carbon-neutral production systems has been shown to significantly reduce carbon emissions, without compromising product quality or market competitiveness (Niu & Wang, 2024). The application of Life Cycle Assessment (LCA) principles has also proven effective in finding more sustainable technical solutions, for example by processing post-consumption glass waste into environmentally friendly and highly energy-efficient building materials (Blengini et al., 2012).

The implementation of green manufacturing practices is increasingly driven by various important factors, such as pressure from government policies and regulations, increasing consumer awareness and demands for environmentally friendly products, and opportunities to improve operational efficiency and reduce production costs. Numerous studies have confirmed that the integration of green strategies in manufacturing processes not only improves environmental performance but also supports the long-term sustainability of businesses. Furthermore, integrated approaches such as implementing Just-in-Time (JIT), Total Quality Management (TQM), and green supply chain practices together have been shown to have a more significant impact on improving environmental performance than if each were implemented separately. The synergy between these three strategies creates a production system that is more efficient, less wasteful, and responsive to market dynamics that increasingly lead to sustainability (Green et al., 2019).

The integration of green manufacturing practices, especially in the Industry 4.0 era, contributes significantly to the creation of sustainable innovation through various strategic mechanisms. This approach encourages increased cross-functional collaboration within the organization and strengthens linkages with both internal and external stakeholders. This also enriches the organization's ability to green absorptive capacity, build long-term partnerships oriented towards sustainability, and direct the company's focus on innovations that support environmental sustainability. These functions synergistically enhance the capacity for innovation in green manufacturing and strengthen the company's ability to produce products that are not only environmentally friendly but also economical and highly competitive in the market (Ghobakhloo et al., 2021). Furthermore, the utilization of key Industry 4.0 technologies such as Manufacturing Execution Systems (MES), Industrial Internet of Things (IIoT), and Additive Manufacturing has been proven to optimize resource use efficiency, significantly lower operational costs, and reduce the environmental impact of the production process (Li et al., 2024). This digital transformation makes manufacturing systems more adaptive, precise, and oriented towards long-term sustainability.

LITERATURE REVIEW

Green Manufacturing

Green manufacturing is a holistic approach and is not limited to the production process. It covers the entire supply chain, from environmentally friendly procurement practices and sustainable product design to collaboration with customers and the implementation of information systems that support environmental sustainability (Ahmad et al., 2022). Green Manufacturing Practices (GMP) include strategic approaches such as Pollution Prevention Practices (PPP) and Product Stewardship Practices (PSP) (Waheed et al., 2020). These strategies are designed to minimize the environmental impact of production activities while encouraging the development of sustainability-oriented products. If implemented consistently, this approach not only improves the efficiency of the manufacturing process but also indirectly influences the formation of environmentally conscious consumer behavior, known as Environmentally Conscious Consumer Behavior (ECCB). Consumers are becoming increasingly aware of the importance of choosing

environmentally friendly products, both in terms of their production process and life cycle, thus driving an increased preference for green products.

Green manufacturing is increasingly recognized as a vital component in achieving sustainable development, particularly for its ability to increase production output without increasing the use of non-renewable resources or putting additional pressure on the environment (Amornkitvikai et al., 2024). This approach promotes efficiency in the use of energy and materials and encourages the use of clean technologies that can reduce emissions and hazardous waste. More than just technical activities, green manufacturing also involves the design of environmentally friendly products that are safe for consumers, do not harm workers, and do not damage the surrounding environment. The main focus of this approach includes liquid waste management, environmental protection, pollution control, and the application of recycling principles in order to support a sustainable product life cycle (Logesh & Balaji, 2021).

Green manufacturing approaches are also closely related to lean manufacturing principles, as both focus on improving operational efficiency and reducing waste at every stage of the production process. Lean manufacturing is a systematic method that focuses on eliminating non-value-added activities (waste), while green manufacturing extends this focus to include aspects of environmental sustainability, such as reducing carbon emissions, hazardous waste, and excessive energy consumption (Alcaraz et al., 2022; Green et al., 2012). When these two approaches are combined, a production system is created that is not only operationally optimal but also environmentally sound and sustainable.

One of the main theoretical foundations in green manufacturing is the Three-Degree Theory, which underlines three key aspects: impact on the environment, efficiency in resource use, and overall system balance. In addition, there is Resource Flow Theory, which highlights the importance of managing resource flows in a closed system, and Product Life Cycle Theory, which emphasizes the need for environmental impact analysis during all stages of the product life cycle. These three theories are combined with the 6R principles (Reduce, Reuse, Recycle, Recover, Redesign, and Remanufacture) to form a holistic approach to realizing sustainability in the industrial sector (Peiji et al., 2021). One of the known framework principles was proposed by Helu and Dornfeld (2013), who put forward five main principles, namely: (1) an integrated system approach, (2) a holistic perspective on the system both vertically and horizontally, (3) efforts to minimize harmful inputs and outputs, (4) reduction of resource consumption, and (5) attention to long-term impacts on the entire system.

Overall, green manufacturing not only acts as a solution to the global environmental crisis but also provides significant strategic benefits to companies, ranging from improved resource efficiency and long-term cost reduction to compliance with environmental regulations. In addition, this approach also strengthens the company's image in the eyes of environmentally conscious consumers, creating a sustainable competitive advantage. This is a very important differentiating element in the midst of increasingly fierce market competition, where companies not only compete on price or product quality, but also on the application of sustainability values. By integrating sustainability principles into their production processes and business strategies, companies are able to create significant differentiation, which not only attracts consumers who are concerned about environmental issues but also has a positive impact on brand image in the long run. This competitive advantage, based on a commitment to sustainability, gives companies a superior position in the market, enabling them to maintain customer loyalty and opening up opportunities to expand market share in sectors that increasingly prioritize environmentally friendly business practices (Ning & Li, 2020).

Sustainable Innovation

Sustainable innovation, also known as green innovation, is a strategic effort to create and implement new products, processes and business models that are not only environmentally friendly but also capable of driving sustainable economic growth. This innovation plays an important role in realizing sustainable development goals (SDGs), especially in the face of various global environmental challenges such as climate change, pollution, and resource scarcity. Utterback and Abernathy explain that innovation is a process that takes place gradually through

three main phases, namely the fluid phase, the transitional phase, and the specific/steady phase. In this context, continuous innovation emerges as a solution to the stagnation that occurs in product and process innovation. By developing innovation in business systems, this approach aims to support the overall sustainability of the organization (Silitonga, 2015).

Cataldo et al. (2021) see sustainable innovation as the result of synergies between technological, social, and environmental innovations, all geared towards supporting the achievement of sustainable development goals. They emphasize the need for a solid theoretical framework to assess the effectiveness of these innovations, both in the short and long term. From an organizational perspective, Taneja et al., (2024) describe sustainable innovation as the result of integration between internal resources, a supportive organizational structure, a strong culture of innovation, and leadership committed to sustainability values. They also developed a conceptual framework detailing the key factors that can drive the implementation of sustainable innovation in corporate practice. Sustainable innovation is a strategic approach that not only focuses on developing new products and services, but also combines technology, business strategy and environmental awareness in an integrated framework. This approach encourages businesses to utilize technological advances in an adaptive way, to improve efficiency and competitiveness, while maintaining a commitment to environmental sustainability.

Sustainable innovation includes various aspects, such as the application of environmentally friendly technologies, the design of sustainability-oriented business models, and the development of products that take into account environmental aspects (Koseoglu et al., 2022; Serhan & Yannou-Lebris, 2021). These initiatives include the utilization of renewable energy, the implementation of environmentally sound production practices, and the development of technologies that aim to reduce the ecological footprint and reduce the rate of environmental degradation (Koseoglu et al., 2022; Sarkar, 2013). Sustainable innovation not only has a positive impact on the environment but also brings economic value, as consumers and businesses are increasingly willing to pay more for ethically and sustainably produced products (Ullah et al., 2024).

The main theory discussed is the sustainable business model as a strategic framework that places sustainability at the core of the value designed, created, distributed, and utilized by the company. This model is not solely oriented towards financial profit, but also incorporates sustainability aspects such as economic, social, and environmental, resulting in more comprehensive and sustainable value in the long term. One of the key approaches in sustainable business model innovation is the application of a three-dimensional value framework, namely value proposition, value creation and delivery, and value capture that is balanced to address economic, social, and environmental needs (Cui et al., 2022). This model also acts as an instrument to encourage the development of environmentally friendly technologies, such as solid waste management and recycling systems, by uncovering potential value that has been overlooked (value uncaptured), such as production waste that has not been utilized or environmental impacts that have not been addressed (Burhan et al., 2021; Yang et al., 2017). Through this framework, companies can convert this potential into business opportunities that not only create sustainable value but also help reduce negative environmental impacts.

Another relevant theory is that Sustainability-Oriented Innovation (SOI) and sustainable leadership are two important pillars in encouraging business practices that are not only economically efficient but also environmentally friendly. SOI emphasizes the integration of economic, social, and environmental values in the innovation process to create sustainable value through strategies such as pollution prevention, sustainable product management, use of clean technology, and vision-based approaches to low-income communities (Ulvenblad et al., 2019). This theory highlights the urgency of organizational change and the development of structured systems to realize sustainability goals. Meanwhile, sustainable leadership theory emphasizes the central role of leaders in building an organizational culture that encourages sustainable innovation. Strong leadership is reflected through the ability to think strategically, holistically, and ethically, which contributes significantly to increasing innovation and achieving corporate sustainability performance, including in the application of circular economy principles (Bashynska et al., 2024; Suriyankietkaew et al., 2022). These theories highlight the importance of

integrating sustainability aspects into the innovation process and business models of companies in order to achieve more optimal economic, environmental, and social performance (Hall & Wagner, 2012; Souto, 2022). In addition, a systems thinking approach is also considered a key principle in evaluating the sustainability level of business model innovation (Schlüter et al., 2023).

METHODS

SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) is a strategic planning method that is used extensively to understand and assess strengths and weaknesses as internal factors, as well as opportunities and threats as external factors of an organization or business environment (Görener et al., 2012). The SWOT analysis method involves a qualitative assessment by mapping the four components; companies can formulate strategies that are more appropriate and responsive to environmental dynamics to create a systematic strategy and support the strategic decision-making process (Gürel, 2017). This approach has proven effective in a variety of industry contexts and has become an important tool in strategic planning and overall organizational management. Qualitative research using SWOT analysis is not only descriptive, but also strategic because it is able to reveal internal and external dynamics in a contextual manner, and formulate more relevant strategies based on the realities observed directly in the field.

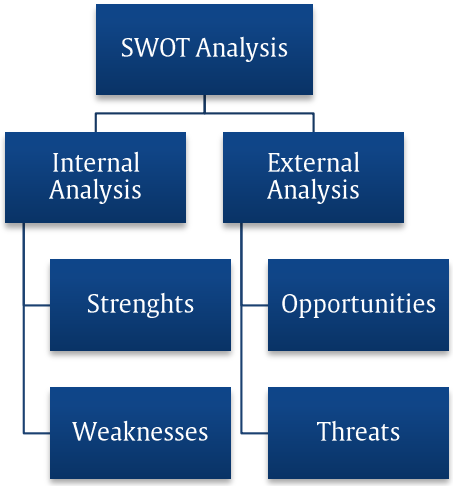

Figure 1. SWOT Analysis Framework

RESULT

SWOT analysis is one of the most widely used tools in strategic planning and decision-making processes in various sectors, including in sustainability efforts and the development of green initiatives (Benzaghta et al., 2021). In the context of sustainability, this analysis serves to systematically identify and evaluate internal factors in the form of strengths and weaknesses, while analyzing opportunities and threats from the external environment that can affect the effectiveness of implementing sustainable practices (Budihardjo et al., 2021; Mollenhorst & de Boer, 2004).

Table 1. SWOT Analysis

No.	SWOT	Key Points	Important Insights	Sources
Internal Analysis				
1.	Strengths (S)	Reduction of emissions and waste	Green manufacturing significantly reduces the carbon footprint and industrial waste.	(Jang et al., 2024)
		Improved operational efficiency	Implementation of green manufacturing improves energy efficiency and productivity.	(Adams et al., 2016)
		Enhanced company reputation	Companies that implement green manufacturing get a positive image from consumers.	(Xie et al., 2024)
2.	Weaknesses (W)	High initial investment cost	Initial investment in green technology is costly	(Tang et al., 2023)
		Lack of technical skill	Limited labor skilled in green manufacturing	(Kumar et al., 2019; Yildiz Çankaya & Sezen, 2019)
		Changes in the production process	Adaptation to green production processes often disrupts routine operations.	(Jang et al., 2024)
External Analysis				
3.	Opportunities (O)	Market demand for green products	Consumers increasingly prefer environmentally friendly products	(Xie et al., 2024)
		Government regulatory support	Many countries provide incentives and initiatives for sustainable production.	(Tang et al., 2023)
		Technology innovation	New technologies support the transformation towards green production	(Adams et al., 2016)
4.	Threats (T)	Cost competition with conventional manufacturers	Green products are often more expensive than regular products	(Yildiz Çankaya & Sezen, 2019)
		Market uncertainty	Fluctuations in market demand for green products are still high	(Xie et al., 2024)
		Risk of rapid policy change	Government policies towards green manufacturing can change at any time	(Kumar et al., 2019)

Through the analysis of internal and external factors using the SWOT approach, companies can formulate more focused and effective strategies for implementing Green Manufacturing (GM) practices in the manufacturing industry. This approach allows companies to identify and strengthen existing strengths, address internal weaknesses, and find market opportunities and technological innovations that support green initiatives while anticipating external challenges. By conducting a comprehensive mapping, companies can not only improve their environmental performance and operational efficiency but also strengthen their competitiveness amid increasing global demands for sustainability. In addition, SWOT analysis provides a solid foundation for strategic decision-making, encourages sustainable product innovation, and opens up opportunities for cross-sector collaboration to accelerate the transformation towards greener and more sustainable manufacturing practices.

No.	SWOT Recommendation	Strategic Step	Refference
1.	Strengthening strengths	Increased investment allocation in environmentally friendly technologies to reduce emissions and waste generated in the production process.	(Afum et al., 2020)
2.	Overcoming internal weaknesses	Creating a sustainability-oriented corporate culture through training programs and active employee participation.	(Runtuk et al., 2024; Sabir et al., 2020)
3.	Finding market opportunities	Collaborate with external parties, such as suppliers, the government, and other external stakeholders, to create a more environmentally friendly supply chain.	(Feng, 2025)
4.	Overcoming external challenges	Carry out ongoing evaluation of environmental performance using measurable indicators to ensure the achievement of long-term sustainability targets.	(Chowdhary et al., 2020)

By implementing these strategic steps, companies are not only able to comply with increasingly stringent environmental regulations but can also strengthen their position in a global market that increasingly prioritizes sustainable production practices. Compliance with regulations is no longer just an obligation, but an added value that enhances the company's reputation in the eyes of consumers, business partners, and investors who are concerned about environmental issues. In addition, the adoption of sustainable practices allows companies to innovate in production processes, optimize resource efficiency, and create more environmentally friendly and high-value products. Thus, companies can build a sustainable competitive advantage while contributing to the achievement of sustainable development goals at the global level.

DISCUSSION

Increasing global environmental pressures and stricter regulations require manufacturing companies to not only focus on production efficiency but also be responsive to the ecological impacts of their operations. In this context, the implementation of green practices and innovative technologies is crucial as an adaptive and proactive strategy. Green technologies such as clean production, energy-efficient processing, and the use of environmentally friendly materials enable companies to reduce waste, lower carbon emissions, and conserve natural resources. Not only does this approach have a positive impact on the environment, but it has also been shown to improve the cost efficiency and competitiveness of companies in the long run. In other words, investing in green practices and technologies is not a burden, but a strategic opportunity to achieve sustainable environmental and economic performance and strengthen market position in an increasingly sustainability-conscious industry.

Green manufacturing strategies have become an important foundation in driving sustainable innovation in the manufacturing sector. These strategies not only focus on reducing environmental impacts, but also drive improvements in efficiency, competitiveness and overall company performance. Sustainable innovation includes the development of environmentally friendly products, the implementation of cleaner production processes, and the use of energy- and resource-efficient technologies. Remanufacturing is seen as one of the key strategies in realizing sustainable manufacturing goals due to its ability to optimize the utilization of used components and reduce waste that ends up in landfills and energy consumption in the production process. By reconditioning and reusing existing components, remanufacturing effectively reduces the need for new raw materials, while significantly reducing carbon emissions and other environmental impacts. In addition, practices such as improving energy efficiency, implementing cleaner production concepts, and adopting green technologies further strengthen the sustainability aspects of remanufactured products from a technical, economic, environmental, and social perspective (Fatimah et al., 2013).

Green manufacturing plays a significant role in supporting the achievement of sustainable innovation goals by improving environmental performance, promoting environmentally friendly products, and strengthening overall sustainability. The integration of green supply chain management, the implementation of environmentally-based innovation strategies, and corporate commitment to environmental social responsibility further strengthens the link between green

manufacturing and the achievement of sustainable innovation (Li et al., 2023; Li et al., 2023). These synergies enable companies to build production systems that are more efficient, adaptive, and responsive to global sustainability challenges, while enhancing reputation, customer loyalty, and long-term competitiveness in an increasingly values-oriented market.

The SWOT framework, which is expanded by considering various internal and external aspects in more depth, can encourage the development and implementation of more comprehensive and effective strategies in various fields. With a sharper analysis of strengths, weaknesses, opportunities and threats, organizations can design solutions that are not only responsive to current conditions but also adaptive to the dynamics of future change (Khiavi et al., 2023). This approach strengthens strategic planning, whether in the context of business, project management, or environmental conservation efforts, by directing the focus on continuous innovation, improved operational efficiency, and better risk management. As such, the enhanced SWOT framework becomes an essential tool for building competitive advantage and supporting the achievement of long-term goals in a variety of sectors.

Thoroughly exploring the results of a SWOT analysis allows companies to develop a more integrated, sustainable innovation strategy that not only prioritizes achieving short-term economic gains but also integrates a commitment to environmental responsibility into their long-term vision and mission. This approach allows companies to balance business objectives and ecosystem preservation while creating broader value for shareholders, society, and future generations. In addition, innovative strategies based on in-depth SWOT analysis help companies cope with regulatory changes, respond to consumer needs for sustainable products, strengthen brand reputation, and capitalize on new opportunities in the rapidly growing green market. Therefore, a comprehensive understanding of SWOT is a crucial strategic foundation to strengthen a company's competitiveness amid the shift towards a sustainable economy.

CONCLUSION

Green manufacturing has become a central strategy in efforts to balance industrial growth with environmental sustainability in the 21st century. Traditional manufacturing practices are known to contribute greatly to environmental degradation, characterized by high levels of waste, greenhouse gas emissions, and excessive consumption of natural resources. In response to this challenge, green manufacturing offers a cleaner, more efficient, and environmentally friendly approach to production, emphasizing principles such as material recycling, reduction of production waste, optimization of energy use, and improved resource efficiency throughout the product lifecycle. The adoption of this concept is further strengthened by various drivers, including government regulatory policies that prioritize sustainability, increasing consumer awareness of the importance of environmentally friendly products, and real opportunities to improve operational efficiency while lowering long-term production costs. In the Industry 4.0 era, the integration of green manufacturing practices is growing increasingly complex and strategic. Cross-functional collaboration, increased organizational capacity to absorb green innovations, and the adoption of cutting-edge technologies such as Manufacturing Execution Systems (MES), Industrial Internet of Things (IIoT), and Additive Manufacturing have become key in accelerating the transformation towards sustainable innovation. Through the utilization of these technologies, companies are not only able to increase the effectiveness of resource use and reduce environmental impact, but also create innovative products that are more competitive in the global market. Thus, green manufacturing is not just an ethical choice, but has become a key business strategy to build industrial resilience, drive green economic growth, and meet global demands for sustainability.

REFERENCES

Adams, R., Jeanrenaud, S., Bessant, J., Denyer, D., & Overy, P. (2016). Sustainability-oriented Innovation: A Systematic Review. *International Journal of Management Reviews*, *18*(2), 180–205. https://doi.org/10.1111/ijmr.12068

Afum, E., Agyabeng-Mensah, Y., Sun, Z., Frimpong, B., Kusi, L. Y., & Acquah, I. S. K. (2020). Exploring the Link between Green Manufacturing, Operational Competitiveness, Firm Reputation and

Sustainable Performance Dimensions: a Mediated Approach. *Journal of Manufacturing Technology Management*, *31*(7), 1417– 1438. https://doi.org/10.1108/JMTM-02-2020-0036

Ahmad, A., Ikram, A., Rehan, M. F., & Ahmad, A. (2022). Going green: Impact of Green Supply Chain Management Practices on Sustainability Performance. *Frontiers in Psychology*, *13*, 1– 12. https://doi.org/10.3389/fpsyg.2022.973676

Alcaraz, J. L. G., Reza, J. R. D., Soto, K. C. A., Escobedo, G. H., Happonen, A., Puig I Vidal, R., & Jiménez Macías, E. (2022). Effect of Green Supply Chain Management Practices on Environmental Performance: Case of Mexican Manufacturing Companies. *Mathematics*, *10*(11), 1877. https://doi.org/10.3390/math10111877

Amornkitvikai, Y., O' Brien, M., & Bhula-or, R. (2024). Toward Green Production Practices: Empirical Evidence from Thai Manufacturers' Technical Efficiency. *Journal of Asian Business and Economic Studies*, *31*(3), 216– 232. https://doi.org/10.1108/JABES-05-2023-0151

Bashynska, I., Malynovska, Y., Kolinko, N., Bielialov, T., Järvis, M., Kovalska, K., & Saiensus, M. (2024). Performance Assessment of Sustainable Leadership of Enterprise's Circular Economy-Driven Innovative Activities. *Sustainability*, *16*(2), 558. https://doi.org/10.3390/su16020558

Benzaghta, M. A., Elwalda, A., Mousa, M., Erkan, I., & Rahman, M. (2021). SWOT Analysis Applications: An Integrative Literature Review. *Journal of Global Business Insights*, *6*(1), 55–73. https://doi.org/10.5038/2640-6489.6.1.1148

Blengini, G. A., Busto, M., Fantoni, M., & Fino, D. (2012). Eco-Efficient Waste Glass Recycling: Integrated Aaste Management and Green Product Development through LCA. *Waste Management*, *32*(5), 1000– 1008. https://doi.org/10.1016/j.wasman.2011.10.018

Budihardjo, M. A., Ramadan, B. S., Putri, S. A., Wahyuningrum, I. F. S., & Muhammad, F. I. (2021). Towards Sustainability in Higher-Education Institutions: Analysis of Contributing Factors and Appropriate Strategies. *Sustainability*, *13*(12), 6562. https://doi.org/10.3390/su13126562

Burhan, Ciptomulyono, U., Singgih, M. L., & Baihaqi, I. (2021). Sustainable Business Model Innovations in the Value Uncaptured Manufacturing Industry: Fitting Gains—Gain Creators. *Sustainability*, *13*(10), 5647. https://doi.org/10.3390/su13105647

Cataldo, R., Grassia, M. G., Mazzocchi, P., Quintano, C., & Rocca, A. (2021). *Innovation and Sustainability: The Italian Scenario* (pp. 71– 76). https://doi.org/10.36253/978-88-5518-304-8.15

Chowdhary, P., Bharagava, R. N., Mishra, S., & Khan, N. (2020). Role of Industries in Water Scarcity and Its Adverse Effects on Environment and Human Health. In *Environmental Concerns and Sustainable Development* (pp. 235– 256). Springer Singapore. https://doi.org/10.1007/978-981-13-5889-0_12

Cui, Y., Cao, Y., Ji, Y., Chang, I., & Wu, J. (2022). Determinant Factors and Business Strategy in a Sustainable Business Model: An Explorative Analysis for the Promotion of Solid Waste Recycling Technologies. *Business Strategy and the Environment*, *31*(5), 2533– 2545. https://doi.org/10.1002/bse.3042

Fatimah, Y. A., Biswas, W., Mazhar, I., & Islam, M. N. (2013). Sustainable Manufacturing for Indonesian Small-and Medium-Sized Enterprises (SMEs): The Case of Remanufactured Alternators. *Journal of Remanufacturing*, *3*(1), 6. https://doi.org/10.1186/2210-4690-3-6

Feng, Z. (2025). Using SWOT Analysis to Assist Chinese Enterprises in Establishing Green Supply Chain Management. *Advances in Economics, Management and Political Sciences*, *161*(1), 188–200. https://doi.org/10.54254/2754-1169/2025.20050

Ghobakhloo, M., Iranmanesh, M., Grybauskas, A., Vilkas, M., & Petraitė, M. (2021). Industry 4.0, Innovation, and Sustainable Development: A Systematic Review and a Roadmap to Sustainable Innovation. *Business Strategy and the Environment*, *30*(8), 4237–4257. https://doi.org/10.1002/bse.2867

Görener, A., Toker, K., & Uluçay, K. (2012). Application of Combined SWOT and AHP: A Case Study for a Manufacturing Firm. *Procedia - Social and Behavioral Sciences*, *58*, 1525–1534. https://doi.org/10.1016/j.sbspro.2012.09.1139

Green, K. W., Inman, R. A., Sower, V. E., & Zelbst, P. J. (2019). Impact of JIT, TQM and Green Supply Chain Practices on Environmental Sustainability. *Journal of Manufacturing Technology Management*, *30*(1), 26–47. https://doi.org/10.1108/JMTM-01-2018-0015

Green, K. W., Zelbst, P. J., Meacham, J., & Bhadauria, V. S. (2012). Green Supply Chain Management Practices: Impact on Performance. *Supply Chain Management: An International Journal*, *17*(3), 290–305. https://doi.org/10.1108/13598541211227126

Gürel, E. (2017). SWOT Analysis: A Theoretical Review. *Journal of International Social Research*, *10*(51), 994–1006. https://doi.org/10.17719/jisr.2017.1832

Haleem, A., Javaid, M., Singh, R. P., Suman, R., & Qadri, M. A. (2023). A Pervasive Study on Green Manufacturing towards Attaining Sustainability. *Green Technologies and Sustainability*, *1*(2), 100018. https://doi.org/10.1016/j.grets.2023.100018

Hall, J., & Wagner, M. (2012). Integrating Sustainability into Firms' Processes: Performance Effects and the Moderating Role of Business Models and Innovation. *Business Strategy and the Environment*, *21*(3), 183–196. https://doi.org/10.1002/bse.728

Helu, M., & Dornfeld, D. (2013). Principles of Green Manufacturing. In *Green Manufacturing* (pp. 107–115). Springer US. https://doi.org/10.1007/978-1-4419-6016-0_5

Huang, J. Y., & Zhu, H. Y. (2014). Analysis of Implementation the Key Technologies of Green Manufacturing. *Applied Mechanics and Materials*, 787–790. https://doi.org/10.4028/www.scientific.net/AMM.522-524.787

Jang, S., Park, S., & Lee, B. (2024). Key elements of Korean Medicine Treatment for Idiopathic Short-Stature: A Qualitative SWOT Analysis based on Korean Medicine Doctors' Views. *Medicine*, *103*(30), e39116. https://doi.org/10.1097/MD.0000000000039116

Khiavi, A. N., Vafakhah, M., & Sadeghi, S. H. (2023). Comparative Applicability of MCDM-SWOT based Techniques for Developing Integrated Watershed Management Framework. *Natural Resource Modeling*, *36*(4). https://doi.org/10.1111/nrm.12380

Koseoglu, A., Yucel, A. G., & Ulucak, R. (2022). Green Innovation and Ecological Footprint Relationship for a Sustainable Development: Evidence from Top 20 Green Innovator Countries. *Sustainable Development*, *30*(5), 976–988. https://doi.org/10.1002/sd.2294

Kumar, V. V., Hoadley, A., & Shastri, Y. (2019). Dynamic Impact Assessment of Resource Depletion: A Case Study of Natural Gas in New Zealand. *Sustainable Production and Consumption*, *18*, 165–178. https://doi.org/10.1016/j.spc.2019.01.002

Li, H., Li, Y., Sarfarz, M., & Ozturk, I. (2023). Enhancing Firms' Green Innovation and Sustainable Performance through the Mediating Role of Green Product Innovation and Moderating Role of Employees' Green Behavior. *Economic Research-Ekonomska Istraživanja*, *36*(2). https://doi.org/10.1080/1331677X.2022.2142263

Li, Q., Tang, W., & Li, Z. (2024). Leveraging Industry 4.0 for Sustainable Manufacturing: A Quantitative Analysis Using FI-RST. *Applied Sciences*, *14*(20), 9545. https://doi.org/10.3390/app14209545

Li, W., Bhutto, M. Y., Waris, I., & Hu, T. (2023). The Nexus between Environmental Corporate Social Responsibility, Green Intellectual Capital and Green Innovation towards Business Sustainability: An Empirical Analysis of Chinese Automobile Manufacturing Firms. *International Journal of Environmental Research and Public Health*, *20*(3), 1851. https://doi.org/10.3390/ijerph20031851

Logesh, B., & Balaji, M. (2021). Experimental Investigations to Deploy Green Manufacturing through Reduction of Waste Using Lean Tools in Electrical Components Manufacturing Company. *International Journal of Precision Engineering and Manufacturing-Green Technology*, *8*(2), 365–374. https://doi.org/10.1007/s40684-020-00216-4

Mollenhorst, H., & de Boer, I. J. M. (2004). Identifying Sustainability Issues Using Participatory SWOT Analysis. *Outlook on Agriculture*, *33*(4), 267–276. https://doi.org/10.5367/0000000042664747

Ning, S., & Li, X. (2020). *A Scientometric Review of Emerging Trends in Green Manufacturing* (pp. 234–247). https://doi.org/10.1007/978-3-030-21248-3_17

Niu, B., & Wang, L. (2024). How Does Green Manufacturing Promote the Recycling of Renewable Solid Waste and Carbon Reduction? *Resources, Conservation and Recycling*, *203*, 107410. https://doi.org/10.1016/j.resconrec.2024.107410

Peiji, L., Fei, L., Xu, W., Zhenbiao, Y., Huajun, C., & Congbo, L. (2021). The Theory and Technology System of Green Manufacturing and Their New Frameworks. *Journal of Mechanical Engineering*, *57*(19), 165. https://doi.org/10.3901/JME.2021.19.016

Runtuk, J. K., Ng, P. K., & Ooi, S. Y. (2024). Challenges and Solutions in Working with Green Suppliers: Perspective from a Manufacturing Industry. *Sustainability*, *16*(20), 8744. https://doi.org/10.3390/su16208744

Sabir, M. R., Rehman, M., & Asghar, W. (2020). Assessing the Mediating Role of Organization Learning Capability between the Relationship of Green Intellectual Capital and Business Sustainability. *Journal of Business and Social Review in Emerging Economies*, *6*(4), 1289–1301. https://doi.org/10.26710/jbsee.v6i4.1416

Sarkar, A. (2013). Promoting Eco-innovations to Leverage Sustainable Development of Eco-industry and Green Growth. *European Journal of Sustainable Development*, *2*(1), 171–224. https://doi.org/10.14207/ejsd.2013.v2n1p171

Schlüter, L., Kørnøv, L., Mortensen, L., Løkke, S., Storrs, K., Lyhne, I., & Nors, B. (2023). Sustainable Business Model Innovation: Design Guidelines for Integrating Systems Thinking Principles in Tools for Early-Stage Sustainability Assessment. *Journal of Cleaner Production*, *387*, 135776. https://doi.org/10.1016/j.jclepro.2022.135776

Serhan, H., & Yannou-Lebris, G. (2021). The Engineering of Food with Sustainable Development Goals: Policies, Curriculums, Business Models, and Practices. *International Journal of Sustainable Engineering*, *14*(1), 12–25. https://doi.org/10.1080/19397038.2020.1722765

Silitonga, R. (2015). Inovasi Sistem Bisnis Sebagai Alternatif Inovasi Produk-Proses di masa Steady/Specific State. *Jurnal Telematika*, *6*(1), 1–4. https://doi.org/10.61769/telematika.v6i1.37

Souto, J. E. (2022). Organizational Creativity and Sustainability-Oriented Innovation as Drivers of Sustainable Development: Overcoming Firms' Economic, Environmental and Social Sustainability Challenges. *Journal of Manufacturing Technology Management*, *33*(4), 805–826. https://doi.org/10.1108/JMTM-01-2021-0018

Suriyankietkaew, S., Krittayaruangroj, K., & Iamsawan, N. (2022). Sustainable Leadership Practices and Competencies of SMEs for Sustainability and Resilience: A Community-Based Social Enterprise Study. *Sustainability*, *14*(10), 5762. https://doi.org/10.3390/su14105762

Taneja, A., Goyal, V., & Malik, K. (2024). Conceptual Framework of Factors Enhancing Sustainability-oriented Innovations. *Abhigyan*, *42*(3), 306–330. https://doi.org/10.1177/09702385241257773

Tang, M., Liu, Y., Hu, F., & Wu, B. (2023). Effect of Digital Transformation on Enterprises' Green Innovation: Empirical Evidence from Listed Companies in China. *Energy Economics*, *128*, 107135. https://doi.org/10.1016/j.eneco.2023.107135

Ullah, S., Ahmad, T., Kukreti, M., Sami, A., & Shaukat, M. R. (2024). How Organizational Readiness for Green Innovation, Green Innovation Performance and Knowledge Integration Affects Sustainability performance of exporting firms. *Journal of Asia Business Studies*, *18*(2), 519–537. https://doi.org/10.1108/JABS-02-2023-0056

Ulvenblad, P., Ulvenblad, P., & Tell, J. (2019). An Overview of Sustainable Business Models for Innovation in Swedish Agri-Food Production. *Journal of Integrative Environmental Sciences*, *16*(1), 1–22. https://doi.org/10.1080/1943815X.2018.1554590

Waheed, A., Zhang, Q., Rashid, Y., Tahir, M. S., & Zafar, M. W. (2020). Impact of Green Manufacturing on Consumer Ecological Behavior: Stakeholder Engagement through Green Production and Innovation. *Sustainable Development*, *28*(5), 1395–1403. https://doi.org/10.1002/sd.2093

Xie, C., He, X., Wang, W., & Wang, J. (2024). Assessing the Impact of Manufacturing Servitization on

the Urban Green Development Efficiency in China. *Clean Technologies and Environmental Policy*. https://doi.org/10.1007/s10098-024-02997-7

Yang, M., Evans, S., Vladimirova, D., & Rana, P. (2017). Value Uncaptured Perspective for Sustainable Business Model Innovation. *Journal of Cleaner Production*, *140*, 1794–1804. https://doi.org/10.1016/j.jclepro.2016.07.102

Yildiz Çankaya, S., & Sezen, B. (2019). Effects of Green Supply Chain Aanagement Practices on Sustainability Performance. *Journal of Manufacturing Technology Management*, *30*(1), 98–121. https://doi.org/10.1108/JMTM-03-2018-0099