

THE INTEGRATION OF LEAN, GREEN AND SUSTAINABLE BUSINESS PRACTICES: FROM LITERATURE REVIEW TO THE DEVELOPMENT MODEL

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Abstract

The lean approach is based on more efficient use of resources and eliminating all kinds of waste that do not add value for customers. Lean manufacturing is considered a necessary strategy for generating financial performance and sustainable finance. There are positive links between lean and green paradigms, so the connection has strength in business communities, industry and academia. One of the main aims of this paper is to explore and highlight lean and green synergies and sustainable practices. In addition, this approach is a catalyst for total waste reduction, so the interdisciplinary aspects of sustainable production and consumption are attracting increasing interest. The research describes public policy and institutional conditions for the establishment and development of an integrated waste management system in the Republic of Serbia until 2031. Special attention is to the models which propose the integration the green-lean solutions and the circular economy concept. Through the principle of continuous improvement business entities can enhance the environmental and resource performance aspects.

Key words: sustainable finance, lean approach, waste management system, green transition, circular economy.

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1. Introduction

In the corporate world, lean methodology and the green transition are not distinct concepts. The interdependence of lean methodology, green transition and sustainable production and consumption is a leading subject in both academia and industry. Integration of lean-green provides a means to addressing issues faced by manufacturing industries for improved competitiveness. To achieve business excellence and mitigate environmental concerns, companies must implement the right tools and consider the critical success factors. By applying appropriate tools and models, the businesses can achieve a reduction in cost significantly (Elemure, Dhakal, Leseure & Radulovic, 2023).

The integrative approach requires a comprehensive alignment with public policy and institutional conditions. The establishment and development of an integrated waste management system necessitate supportive regulations, policies, and infrastructure to promote sustainable practices. Public policies need to encourage businesses to adopt lean and green principles by offering financial incentives, creating a conducive regulatory environment, and providing access to resources for implementing sustainable waste management systems. Additionally, institutional frameworks play a crucial role in facilitating coordination between various stakeholders, monitoring compliance with environmental standards, and fostering collaborations among industries to align their operations with sustainable practices. By incorporating public policy initiatives and strengthening institutional capacities, the Republic of Serbia can advance towards achieving its waste management goals and transitioning towards a more sustainable and environmentally conscious ecosystem (Waste management program in the Republic of Serbia for the period 2022 – 2031. „Službeni glasnik RS”, broj 30/18).

This paper is organized as follows. After introduction, the paper presents a brief theoretical background. Section 3 explains the research design. Subsequently, Section 4 discusses the main findings and recommendations. Lastly, Section 5 highlights the main drivers and barriers for integration lean and green concepts and gives conclusions.

2. Theoretical background

Examining the connection between Lean and Green goes back to the early days of Lean the manufacturing process (Martinez & Jirsák, 2024). The integration of Lean and Green in business practices is considered one of the great solutions to balancing operational gains and environmental sustainability. It is condition sine qua non for sustainable finance and development. Lean and green concepts can be integrated as shown in Figure 1.



Figure 1: Lean and green integration

Source: Elemure, Dhakal, Leseure & Radulovic, 2023.

The latest research shows that Lean and Green are synergistic in most business practices, but they must be managed according to the Operations Strategy, especially as their focuses are essentially different and trade-offs may occur. Figure 2 gives a framework for Lean Green integration and emphasizes some integrated tools such as 7s which is, 5s plus S (safety) and S (sustainability) and Green Lean Six Sigma (Cherriafi, Elfezazi, Chiarini, Mokhlis & Benhida, 2016). There are some systematic studies that focus on integrated approach which can obtain the maximum operational performance without compromising the environment (Leong et al., 2020).



Figure 2. Relationships between the concepts, method and results

Source: Queiroz, Delai, Alves Filho, Santa-Eulalia & Torkomian, 2023.

Complementary, holistic understanding of these relationship enables the transition to sustainable business (Caldera, Desha & Dawes, 2019). Some authors

demonstrate that Lean aims to reduce waste in the value chain, to reduce costs and defects and to increase resources efficiency (Garza-Reyes, Kumar, Chaikittisilp & Tan, 2018). Large firms have gained collaborative synergy in the correlation between green practice and sustainability performance of supply chain, however, small and medium-sized businesses (SMEs), who are important stakeholders should also be encouraged to use lean and green practices to support the larger companies in the supply chain (Kosasih, Pujiawan, Karningsih & Shee, 2023).

3. Research Design and Methodology

This paper integrates both qualitative and quantitative approaches to provide a comprehensive analysis of the integration of lean, green, and sustainable business practices. Data Collection Methods involved primary and secondary data collection methods. Primary data will be gathered through in-depth interviews and observations, while secondary data will be collected from existing relevant literature and reports. The sample size was determined on the concept of data saturation. A comprehensive review of existing literature on lean, green, and sustainable business practices will be conducted to understand the current state of research and identify gaps in knowledge. In addition, a conceptual framework will be developed based on the findings of the literature review to guide the integration of lean, green, and sustainable business practices. The described interdependence could be validated through expert reviews and feedback from industry practitioners to ensure its applicability and relevance in the real-world business environment. The paper gives some recommendations for organizations looking to enhance their business practices through the integration of lean, green, and sustainable initiatives, as well as recommendations for potential directions for future study. By following research design, the paper aims to contribute to the understanding of how organizations can effectively integrate lean, green, and sustainable practices for long-term market success.

4. The main findings and recommendations

Table 1 compares the Lean and Green paradigms regarding several aspects: focus of the concept and philosophy, organizational culture, process orientation, performance measurement, management and employee involvement, and supply chain involvement. The analysis shows that the concepts display similarities at the level of resource productivity, organizational change, and source reduction, but implementation can lead to trade-off situations. The main reason is a different generic focus, so this duality needs to be managed in business processes. In this regard, table 1 also systematizes the benefits that companies can expect if they follow the principles of lean and green paradigms in their daily production and service systems.

Table 1: Lean versus Green Paradigm

Characteristics	Lean Paradigm	Green Paradigm
<i>Focus and Philosophy</i>	Waste elimination and continuous improvement. Long term thinking	Reduction of environmental impact and priority to sustainability. Long term thinking
<i>Organizational Culture</i>	Use of horizontal organizational structure	Reduce environmental impact through cross functional relations
<i>Process orientation</i>	Improving processes	Develops a sustainable process. Focus on both process and products
<i>Performance Measurement</i>	Resolves problems through feedback	Evaluation through green reporting
<i>Management Involvement</i>	Involves top management involvement and satisfaction	Involves management commitment
<i>Employee involvement</i>	Training and empowerment of employees	Employees should be educated
<i>Supply chain involvement</i>	Customer focus and close cooperation with suppliers	Involvement of suppliers is essential
	Lean Paradigm	Green Paradigm
<i>Benefits</i>	Eliminate overproduction by consuming less material and reduce the cost associated with inventory	Circular economy encourages the recycling and reuse of materials
	Waiting time is improved upon to reduce production downtime	The cost of energy while operating is reduced
	Unnecessary transportation increases the price associated with the product	Emission and carbon footprints caused by unnecessary transportation are reduced
	Fewer materials are used by eliminating defects	Less energy usage is attained with the use of the appropriate number of materials
	Excessive movement and lifting of materials are completely reduced	Less energy is consumed while eliminating unnecessary motion, lifting and transferring of materials

Source: Authors systematization according to Duarte & Cruz Machado, 2017.

Some studies have suggested several lean-green implementation models used by industries in developed countries:

1. Combined tools framework. The implementation of this model allowed energy consumption reduction. Additionally, using various tools, such as Kanban, 5S, kaizen and visual management, the material usage can be improved (Siegel, Antony, Garza-Reyes, Cherrafi & Lameijer, 2019).
2. Overall greenness performance for value stream mapping (OGP-VSM) model. The main findings refer to the emission of the various processes as well as non-value-added activities were identified (Muñoz-Villamizar, Santos, Garcia-Sabater, Lleo & Grau, 2019).
3. Lean and Green House and maturity model. In order to help eliminate manufacturing waste as well as environmental waste, this process entails identifying and putting strategies into place (Verrier, Rose & Caillaud, 2016).
4. Lean and Green Model. This approach aims to lower average energy use, hazardous waste, and resource use (Pampanelli, Found & Bernardes, 2014).
5. The Sustainable Value Stream Mapping (Sus-VSM) model. This model included not just finding waste and producing value cheaply, but also evaluating the workers' ergonomic conditions (Faulkner & Badurdeen, 2014).
6. Gemba-Kaizen model. It demonstrated how the lean green implementation methodology may aid in enhancing the companies' environmental and operational performance (Cherrafi, et al., 2019).

The mentioned models provide a customer-centric application and highlights the eliminating different Lean production waste (transportation, inventory, motion, waiting time, overproduction, over processing, defects) which can provide numerous benefits such as reduced lead time, improved financial performance, reduced risk, increased customer satisfaction, quality, and efficiency (Fercoq, Lamouri & Carbone, 2016). Considering all the above, it can be stated that a universally accepted model for integration lean and green implementation is lacking to achieve balance sustainability, environmental responsibility, and operational excellence. The future research should be focused on developing a decision-making model facilitating lean tool implementation based on a company's priorities for economic and environmental performance.

5. Conclusion

On the one hand, the main drivers to integration of lean and green practice are: market pressure and expectations, foreign investment, long term economic benefits and performance, management and workers commitment, positive government policies and regulations, reduced waste and lower cost of manufacture, technological transfer and innovation, research and development and workers training. On the other hand, lean barriers are lack of expertise and technical training, low technological capabilities, lack of continuous improvement culture, requires financial capital. The key green barriers are less interest in environmental issues

and resistant to change, lack of environmental awareness, recycling can be expensive and challenging.

It is evident that the integration of lean, green, and sustainable business practices is vital for achieving competitive advantage and addressing environmental concerns in industries. The synergies between lean and green paradigms can lead to enhanced operational efficiency, reduced waste, and improved sustainability performance. Various implementation models have been highlighted, such as the Combined Tools Framework, OGP-VSM Model, Lean and Green House Model, Sustainable Value Stream Mapping, and Gemba-Kaizen Model, which offer strategies for reducing energy consumption, improving material usage, and eliminating waste in both production processes and environmental practices. To sum up, the integration of lean and green practices not only fosters operational excellence but also contributes to sustainable development and resource efficiency in businesses. By adopting appropriate tools and models tailored to their specific needs, companies can achieve cost savings, environmental benefits, and competitive advantages. Encouraging the implementation of lean-green approaches among both large corporations and SMEs is essential for creating a more sustainable supply chain and promoting a circular economy that prioritizes environmental impact mitigation alongside operational effectiveness.

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REFERENCES

- [1] Caldera, H. T. S., Desha, C., & Dawes, L. (2019). Evaluating the enablers and barriers for successful implementation of sustainable business practice in 'lean' SMEs. *Journal of cleaner production*, 218, 575-590.
<https://doi.org/10.1016/j.jclepro.2019.01.239>
- [2] Cherrafi, A., Elfezazi, S., Hurley, B., Garza-Reyes, J. A., Kumar, V., Anosike, A., & Batista, L. (2019). Green and lean: a Gemba-Kaizen model for sustainability enhancement. *Production Planning & Control*, 30(5-6), 385-399.
<https://doi.org/10.1080/09537287.2018.1501808>
- [3] Cherrafi, A., Elfezazi, S., Chiarini, A., Mokhlis, A., & Benhida, K. (2016). The integration of lean manufacturing, Six Sigma and sustainability: A literature review and future research directions for developing a specific model. *Journal of Cleaner Production*, 139, 828-846.
<https://doi.org/10.1016/j.jclepro.2016.08.101>

- [4] Duarte, S., & Cruz Machado, V. (2017). Green and lean implementation: an assessment in the automotive industry. *International Journal of Lean Six Sigma*, 8(1), 65-88. <https://doi.org/10.1108/IJLSS-11-2015-0041>
- [5] Elemure, I., Dhakal, H. N., Leseure, M., & Radulovic, J. (2023). Integration of lean green and sustainability in manufacturing: a review on current state and future perspectives. *Sustainability*, 15(13), 10261. <https://doi.org/10.3390/su151310261>.
- [6] Faulkner, W., & Badurdeen, F. (2014). Sustainable Value Stream Mapping (Sus-VSM): methodology to visualize and assess manufacturing sustainability performance. *Journal of cleaner production*, 85, 8-18. <https://doi.org/10.1016/j.jclepro.2014.05.042>
- [7] Fercoq, A., Lamouri, S., & Carbone, V. (2016). Lean/Green integration focused on waste reduction techniques. *Journal of Cleaner production*, 137, 567-578. <https://doi.org/10.1016/j.jclepro.2016.07.107>
- [8] Garza-Reyes, J. A., Kumar, V., Chaikittisilp, S., & Tan, K. H. (2018). The effect of lean methods and tools on the environmental performance of manufacturing organizations. *International Journal of Production Economics*, 200, 170-180. <https://doi.org/10.1016/j.ijpe.2018.03.030>
- [9] Kosasih, W., Pujawan, I. N., Karningsih, P. D., & Shee, H. (2023). Integrated lean-green practices and supply chain sustainability framework. *Cleaner and Responsible Consumption*, 11, 100143. <https://doi.org/10.1016/j.clrc.2023.100143>.
- [10] Leong, W. D., Teng, S. Y., How, B. S., Ngan, S. L., Abd Rahman, A., Tan, C. P.,... & Lam, H. L. (2020). Enhancing adaptability: Lean and green strategy towards the Industry Revolution 4.0. *Journal of cleaner production*, 273, 122870. <https://doi.org/10.1016/j.jclepro.2020.122870>
- [11] Martinez, F. & Jirsák, P. (2024). Exploring the relationship between Lean and Green for further research, *Journal of Manufacturing Technology Management*, 35(9), pp. 73-93. <https://doi.org/10.1108/JMTM-05-2023-0165>.
- [12] Muñoz-Villamizar, A., Santos, J., Garcia-Sabater, J. J., Lleo, A., & Grau, P. (2019). Green value stream mapping approach to improving productivity and environmental performance. *International Journal of Productivity and Performance Management*, 68(3), 608-625. <https://doi.org/10.1108/IJPPM-06-2018-0216>
- [13] Pampanelli, A. B., Found, P., & Bernardes, A. M. (2014). A Lean & Green Model for a production cell. *Journal of cleaner production*, 85, 19-30. <https://doi.org/10.1016/j.jclepro.2013.06.014>
- [14] Queiroz, G. A., Delai, I., Alves Filho, A. G., Santa-Eulalia, L. A. D., & Torkomian, A. L. V. (2023). Synergies and Trade-Offs between Lean-Green Practices from the Perspective of Operations Strategy: A Systematic Literature Review. *Sustainability*, 15(6), 5296. <https://doi.org/10.3390/su15065296>.
- [15] Siegel, R., Antony, J., Garza-Reyes, J. A., Cherrafi, A., & Lameijer, B. (2019). Integrated green lean approach and sustainability for SMEs: From literature review to a conceptual framework. *Journal of cleaner production*, 240, 118205. <https://doi.org/10.1016/j.jclepro.2019.118205>

- [16] Verrier, B., Rose, B., & Caillaud, E. (2016). Lean and Green strategy: the Lean and Green House and maturity deployment model. *Journal of cleaner production*, 116, 150-156. <https://doi.org/10.1016/j.jclepro.2015.12.022>
 - [17] Waste management program in the Republic of Serbia for the period 2022 – 2031. „Službeni glasnik RS”, broj 30/18).
https://www.ekologija.gov.rs/sites/default/files/2022-02/program_upravljanja_otpadom_u_rs_za_period_2022-2031._god_0_2.pdf



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