Lean Supply Chain Management

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Abstract

In current competitive market, efficient supply chain management is essential to achieving sustainable business success. This paper explores the integration of lean principles into supply chain operations and its impact on enhancing the value creation stream. Lean principles, originally developed in the manufacturing sector, focus on waste reduction, continuous improvement, and value maximization from the customer perspective. By applying these principles to supply chain management, organizations can streamline processes, reduce costs, and improve overall efficiency.

The study investigates key lean methodologies, such as Just-In-Time inventory, Total Quality Management and the 5S system, and examines their application in various stages of the supply chain, including procurement, production, and distribution. Through a combination of case studies and empirical data, the research highlights how lean initiatives lead to significant improvements in supply chain performance metrics, such as lead time, inventory levels, and defect rates.

Findings demonstrate that lean supply chain practices foster a culture of continuous improvement and collaboration among supply chain partners, ultimately enhancing the responsiveness and agility of the supply chain. Furthermore, the paper discusses the challenges and best practices for implementing lean principles in supply chain management, providing a roadmap for organizations seeking to optimize their supply chain value creation. The application of lean principles in supply chain management not only drives operational excellence but also contributes to greater customer satisfaction and competitive advantage. This paper underscores the strategic importance of lean thinking in creating a robust and value-driven supply chain.

Keywords: lean, supply chain, lean automotive, performance improvement, waste reduction, just in time, 5S

JEL classification: O00, M16

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1. Introduction

In a dynamic market environment, characterized by intense competition and increasingly demanding clients, companies must focus on reducing costs to remain competitive and meet market needs. Over the past few years, many companies have adopted the Lean thinking philosophy, implementing actions that significantly reduce waste. Now, more than ever, companies are seeking alternatives to minimize activities that do not add value to the product, which is crucial for any business, as presented also by Osunsanmi et al. (2019).

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The primary objective of this study was to reduce the production costs of a manufacturing plant. This goal was pursued on an existing and recently installed production line, with a particular focus on improving the line layout. This project had a substantial impact on factory costs, as each cost reduction measure can significantly affect the total cost of industrialization and production. To achieve these improvements, waste was identified and diagnosed using Lean tools. Measures such as optimizing machine processing times, balancing the production line, and reducing the number of machines were implemented.

Several contributions stem from this study, with the most notable being: 1) Significant cost reductions achieved without major physical changes to production line equipment; 2) Applicability of the study to similar production lines; 3) Contribution to the scientific literature focused on production line improvements.

2. Literature review

Lean process improvement has been extensively studied and documented by various authors, each contributing unique insights and practical methodologies to enhance organizational efficiency and value creation. Womack, in 1992, on the book "The machine that changed the world", used for the first time the expression Lean Manufacturing, doing a retake of the history of automobile production combined the Japanese, American and European production lines. Lean Manufacturing (LM) consists of producing, by maximizing the economy of resources, to represent the products developed in Toyota. Liker (2004) explores the 14 management principles that underpin Toyota's success, emphasizing long-term philosophy, continuous improvement, and respect for people. His main conclusion is that the adoption of these principles can transform organizational culture and operations, leading to sustainable competitive advantage.

Womack and Jones (2003) introduce the principles of lean thinking, including value specification, value stream mapping, flow, pull, and perfection. They conclude that organizations adopting these principles can significantly reduce waste, improve quality, and enhance customer value, leading to increased profitability.

Ries (2011) applies lean principles to the startup environment, advocating for rapid prototyping, validated learning, and iterative product development. He concludes that this approach minimizes risk and maximizes innovation, enabling startups to pivot quickly in response to market feedback and achieve sustainable growth.

Imai (1997) emphasizes the importance of continuous improvement (Kaizen) on the shop floor (Gemba). He concludes that small, incremental changes, driven by frontline employees, can lead to substantial improvements in efficiency and quality, fostering a culture of ongoing improvement.

In "Lean Solutions," Womack and Jones (2005) extend lean principles to service and customer interactions. They conclude that organizations can enhance customer satisfaction and value by eliminating waste in all aspects of the customer experience, not just in manufacturing.

Womack, Jones, and Roos (1990) analyze the rise of lean production and its impact on the global automotive industry. The authors conclude that lean production systems, characterized by efficiency and waste reduction, outperform traditional mass production methods, providing a competitive edge in the marketplace.

Martin and Osterling (2013) provide a detailed methodology for visualizing and improving value streams. They conclude that value stream mapping is a powerful tool for identifying inefficiencies and aligning leadership efforts towards continuous improvement, ultimately enhancing organizational performance.

Goldratt and Cox (2004) introduce the Theory of Constraints, which complements lean principles. They conclude that identifying and addressing the primary constraint in any process leads to significant improvements in throughput and efficiency, supporting lean objectives of waste reduction and continuous improvement.

In conclusion, these authors collectively highlight the transformative potential of lean principles across various sectors. Their findings emphasize waste reduction, continuous improvement, and a customer-centric approach as key drivers of organizational success and competitive advantage. A typical representation of lean improvement in waste reduction processes is through a Value Stream Map (VSM). A VSM visually represents the flow of materials and information required to bring a product or service to a customer, highlighting areas of waste and opportunities for improvement.

3. Research Methodology

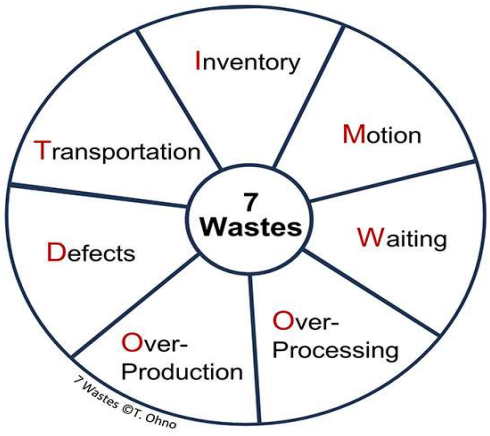
The literature review focuses on examining existing research and publications related to lean process improvement within the automotive industry. A systematic search will be conducted using academic databases such as PubMed, Scopus, and Google Scholar, employing keywords including "lean manufacturing," "automotive industry," and "process improvement." Studies published within the last 10 years, specifically focusing on lean principles and practices within the automotive sector are included. Relevant articles, books, and reports will be gathered and analyzed to extract key findings, methodologies, and conclusions related to lean process improvement in automotive manufacturing. Information from the selected literature will be synthesized to identify common themes, trends, and gaps in the current understanding of lean process improvement in the automotive industry.

The qualitative component of the study aims to gather insights and perspectives from industry practitioners and experts in lean process improvement within the automotive sector. Key stakeholders, including manufacturing managers, process engineers, and lean practitioners, will be purposively selected based on their expertise and experience in lean automotive manufacturing. Survey will be applied as a next step of this study, to explore participants' experiences, challenges, and best practices in implementing lean principles within automotive manufacturing processes. Thematic analysis will be used to identify recurring patterns, themes, and insights from the interview transcripts. Findings from the qualitative study will be compared and contrasted with the results of the literature review to validate and enrich the understanding of lean process improvement in the automotive sector. The combined approach of literature review and qualitative study will provide a comprehensive understanding of current practices, challenges, and opportunities in lean process improvement within the automotive industry. Insights gained from this research will contribute to advancing knowledge and informing future initiatives aimed at enhancing efficiency and competitiveness in automotive manufacturing.

4. Results and findings

Lean Thinking concept is described as being a philosophy that imposes less time since the order placement, obtaining products and services with high quality and low cost, through improvement of production fluxes, by reducing wastes on the flux chain, that we can see through Value Stream Mapping (VSM) or Waste Identification Diagram (WID). Applying this tool brings real advantages, as proved by authors. The authors stated that it could reduce 2,5 days the Production Lead-Time (PLT), and, the value added-time lowered from 68 minutes to 37 minutes. LM philosophy aims to eliminate wastes, to potentiate (in Japanese called) MUDA that reflects the need to reduce waste in order to increase profitability. It corresponds to everything that is not the minimal quantity of equipment, materials, space and time necessary to add value to a product. The most common wastes that can exist in a production system, are classified in seven types: Overproduction, excessive stock, transport, unnecessary dislocations, waiting, defects and over processing.

Figure 1. Types of waste



Source: https://www.kaufmanglobal.com/glossary/7-types-waste/

Garnett et al. (1998) find that viability in the marketplace depends on two factors: developing a steady supply of work so that teams can move from project to project, enhancing their learning and improving both the product and the delivery process; and maintaining steady teams within the alliances. This allows investment and innovation to create new processes and technologies to meet new challenges.

Tortorella et al. (2017) shows that Lean Manufacturing (LM) is widely regarded as one of the most prevalent and influential production systems. Extensive evidence in the literature demonstrates a positive correlation between the implementation of LM principles and significant improvements in various aspects of operational performance. These improvements include increased efficiency, reduced waste, enhanced product quality, and greater responsiveness to market demands. Numerous case studies and empirical research underscore the benefits of LM, highlighting its effectiveness in streamlining processes and fostering a culture of continuous improvement within organizations. The author also references the definition of Lean supply chain management (LSCM) as a network of organizations connected through the upstream and downstream flows of products, services, information, and funds. These organizations collaborate to minimize costs and waste by efficiently pulling resources based on the specific demands of individual customers.

This paper addresses two research questions: which are the best practices of LSCM and what is the association between LSCM best practices, supply chain context and performance.

Figure 2. Supply chain management practices

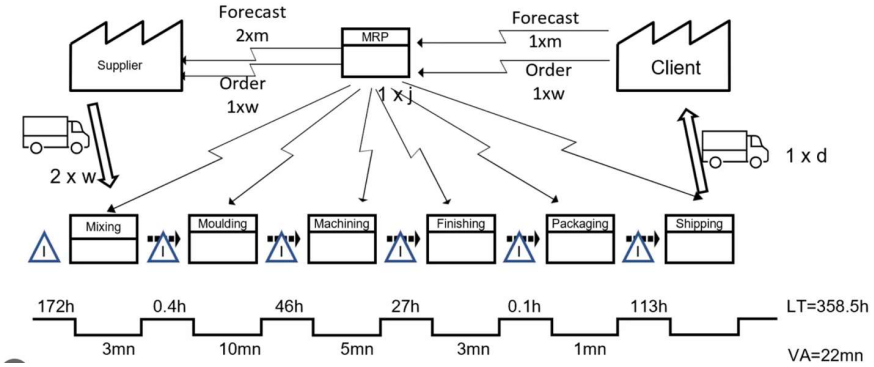
LSCM practices and their appearance in key references.

LSCM practices	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
$LSCM_1$ – *Kanban* or pull system	*	*	*	*	*	*	*		*					*	*	*	*	*	*	*	*	*		*	*	*
$LSCM_2$ – Close relationship between customer, supplier and relevant parties	*	*	*			*	*		*	*	*		*		*	*	*		*	*	*	*		*		*
$LSCM_3$ – Leveled scheduling or *heijunka*	*	*	*	*	*	*	*							*	*	*	*	*	*	*	*	*			*	*
$LSCM_4$ – Efficient and continuous replenishment	*			*		*	*		*								*		*	*	*	*	*	*		
$LSCM_5$ – Two-way feedback assessment	*	*				*	*		*	*					*		*		*		*	*	*			
$LSCM_6$ – Value chain management team		*					*					*			*	*			*	*	*	*	*	*		
$LSCM_7$ – Win-win problem solving methodology	*	*				*	*						*		*				*		*	*	*			
$LSCM_8$ – Value chain analysis or Value stream mapping			*		*									*	*			*	*	*	*	*		*		
$LSCM_9$ – *Keiretsu* (suppliers play a strategic role marshalling the efforts of their own suppliers)	*					*	*	*	*	*					*				*		*					
$LSCM_{10}$ – *Kyoryokukai* (suppliers' association that enhance lateral communication among suppliers, and act as an extra bulwark against customer opportunism)	*						*		*						*	*	*		*		*					*
$LSCM_{11}$ – Intervention strategy (customer is able to cooperatively intervene in the supplier's business operation and bring about change for better)	*						*	*		*	*						*		*		*			*		
$LSCM_{12}$ – Material handling systems				*	*							*			*			*	*		*				*	*
$LSCM_{13}$ – Standardized work procedures to assure quality achievement	*											*			*		*		*		*	*		*	*	
$LSCM_{14}$ – Open-minded and in depth market research conducted jointly (joint understanding of end-user requirements so that all players can work towards providing customer value)			*	*			*		*						*				*	*	*	*				
$LSCM_{15}$ – Open-book negotiation	*				*		*					*					*		*		*		*			
$LSCM_{16}$ – Inbound vehicle scheduling		*										*	*	*	*		*				*					*
$LSCM_{17}$ – *Hoshin Kanri* (policy deployment and development of a strategy for the supply chain)					*		*				*				*	*	*		*		*					
$LSCM_{18}$ – Development of supply chain KPIs					*		*		*						*		*				*					*
$LSCM_{19}$ – Outbound transportation		*											*	*			*				*				*	*
$LSCM_{20}$ – Establishment of distribution centers					*							*		*							*					*
$LSCM_{21}$ – Consignment stock																*					*		*		*	
$LSCM_{22}$ – Functional packaging design																					*					*

Authors: (1) Lamming, 1996; (2) Levy, 1997; (3) Naylor et al., 1999; (4) Jones et al., 2000; (5) McCullen and Towill, 2001; (6) Stratton and Warburton, 2003; (7) Alves Filho et al., 2004; (8) Liker, 2004; (9) Yusuf et al., 2004; (10) Bruce et al., 2004; (11) Power, 2005; (12) Vitasek et al., 2005; (13) Agarwal et al., 2006; (14) Goldsby et al., 2006; (15) Taylor, 2006; (16) Cagliano et al., 2006; (17) Anand and Kodali, 2008; (18) Wee and Wu, 2009; (19) Perez et al., 2010; (20) Naim and Gosling, 2011; (21) Jasti and Kodali, 2015; (22) Theagarajan and Manohar, 2015; (23) Petra and Marek, 2015; (24) Boonsthonsatit and Jungthawan, 2015; (25) Chiromo et al., 2015; (26) Riet et al., 2015.

Source: https://www.sciencedirect.com/science/article/abs/pii/S0925527317302232

Figure 3. Value Stream Mapping (VSM)



Source: https://www.wevalgo.com/know-how/lean-management/lean-methods-tools/vsm

McDermott et al. (2023) show that implementing Lean practices within supply chains is often hindered by challenges such as inadequate understanding and ineffective strategies. Understanding the impact of emerging technologies like Cloud Computing, Big Data, IoT, and AI on Lean Supply Chain (LSC) outcomes is crucial. These technologies affect operational flexibility, quality enhancement, delivery and service levels, and financial performance metrics such as revenue, profits, and market share. Successful implementation of Lean practices relies on strong organizational support and leadership, which moderate the relationship between the Supply Chain Operations Reference Model (SCORM) and Lean Manufacturing (LM), driving optimization in supply chain operations.

Martinez et al. (2014) shows the interplay between Lean Management, Supply Chain Management, and Sustainability, identifying challenges in sustaining Lean Management results and the growing interest in linking Lean principles with environmental sustainability. Expanding Lean practices across the supply chain is crucial for maximizing benefits, but integration with suppliers and customers presents challenges. The emerging frontier of Lean Management is its connection to sustainability, prompting further investigation into its impact on environmental, economic, and social aspects.

So et al. (2015) introduced a research model to illustrate the causal connections between lean thinking as sustainable organizational practices and the adoption of Sustainable Supply Chain Management. Three key dimensions influencing adoption were identified: the level of Sustainable Supply Chain Management integration into daily operations, the extent of e-enablement for supplier integration, and Extended Sustainable Capabilities-enabled organizational integration, and the degree of internal lean practice thus understanding the causal relationship between Sustainable Supply Chain Management and lean operations through prominent industry practices, namely lean thinking and Supply Chain Management.

Figure 4. 5S Metodology

Source: https://blog.proactioninternational.com/en/everything-about-5s

By applying lean tools it was possible to reduce inventory level, that led to minimization of the other seven wastes mentioned previously. The 5S's main goal is to achieve a state of cleanliness and organization that promotes the efficiency and effectiveness of the production environment in an organization. The great benefit of applying the 5S methodology is the obtained discipline in the productive space. However, there are others, such as standardization and documentation that can lead

to reduced cycle times, efficiency gains and less movement, which directly affect transport and inventory waste. This methodology has several benefits for the organization as a whole, of which the most relevant is the reduction of waste, time and space. The application benefits of the 5S range from quality to hygiene and safety. A tool in the productive context is the methodology of standard work, which aims to standardize the sequence and execution of activities at each workstation. This ensures that procedures are carried out in the same way, regardless of the employee involved. However, before this can be undertaken, the production levelling must be considered in order to achieve balance workloads in each workstation and smooth production flow, thus meeting the required demand. This methodology was implemented by Rosa et al. in a production line during the peak years of production life cycle leading to an increase in production of 41 %. As shown in reference, a well-designed layout led to reduced cycle times using the same number of operators, better workload distribution, resulting in a 10% raise in productivity.

Reyes et al. (2023) study shows that Lean Supply Chain Management (LSCM) improves system flow by eliminating non-value-added activities. Key practices include information technology management, supplier management, waste elimination, Just-In-Time (JIT) production, customer relationship management, logistics management, top management commitment, and continuous improvement. Lean Manufacturing identifies seven traditional waste types: overproduction, inventory, extra processing, motion, waiting, defects, and transportation. Lean practices reduce costs and enhance process flows but face challenges like feedback evaluation and value chain management. Global supply chains, while efficient, are vulnerable to disruptions and epidemic outbreaks.

Garcia Buendia et al. (2023) examines four main factors: competitive intensity, strategic supplier performance, Lean Supply Chain Management (LSCM), and efficient growth.Competitive intensity measures the level of competition in the industry, while strategic supplier performance assesses the reliability, quality, flexibility, and cost-effectiveness of key suppliers. LSCM implementation is evaluated through the adoption of waste removal tools, operationalization, and strategic planning along the supply chain. Efficient growth is determined by objective performance metrics such as return on assets (ROA) and sales growth.

Alkhawaldah et al. (2023) is connecting Lean supply chains to operational performance. Lean supply chains are crucial for modern businesses, focusing on promptly and efficiently meeting evolving customer demands. They address fluctuating demands and short product life cycles while responding to delivery requests in terms of quantity, quality, and speed. Operational performance encompasses an organization's efficiency in utilizing available resources to achieve

its goals. It directly impacts financial outcomes and contributes to product quality, customer satisfaction, and business performance metrics like market share. Operational performance is measured through indicators such as financial performance, operational metrics, non-financial measures, and efficiency and effectiveness metrics.

As per Manzouri and Rahman (2013) study in comparison SCM theories which could have connection to LSCM by conducting extensive literature review of supply chain leading journals, concluding that multiple SCM theories are compatible with LSCM principles, such as: time best competition has correspondent perfect time in lean manufacturing, the theory of constraints, system theory, just in time, organisational learning, resource based-view and social capital have correspondence in waste reduction, resource dependent, game theory, network theory and information theory are linked with partner's relationships.

Wincel (2003) makes a clear diferentiation between lean and supply chain management focusing on the cost improvement opportunities of combining the two concepts. Supply chain management is often considered the product movement and delivery but is actually far more complex sistem that is accounting for approximately 50% of the cost of goods sold in a typical manufacturing company, while manufacturing is taking up to 30% ratio of selling price, remaining approximately 20% for gross profit, therefore 1 dollar optimisation in supply chain cost saving is equivalent to profit improvement of 5 dollars selling price increase. Also, while lean is tipically associated with manufacturing operations and material management within an environment, describing the tools and methods by which to implement and quantify success. It is of critical importance to be considered the pre-activities that need to be available in the supply chain to allow the lean efforts to materialize.

5. Conclusion

Lean philosophy equips companies with powerful tools for cost-effective solutions, boosting productivity. Through Lean thinking, the production process can be optimized, showing areas for improvement and eliminating wastes such as over-processing, transportation, and unnecessary motion. By maximizing workstation utilization, the production area can benefit from more efficient use. As a result, significant saving can be achieved from the total investment planned for a certain project, representing often high percentage of the the total investment. The lean approach can be successfully applied outside manufacturing sector, in particular to supply chain management practices, targeting to eliminate waste, improve processes and relationships between business partners and delivering a better product and service to the final customer. Target for continuous improvement remains,

encouraging the industry to deliver value to customers from the customer's perspective, not the traditional risk-averse route.

As concluded by Alvim et al. (2020), the acceptance of improvement philosophies and a lean culture presents opportunities to enhance quality and service in all sectors. However, challenges persist due to demand volatility and extensive human involvement even if the most recent technological advancements have significantly facilitated its progress.

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