IMPACT OF LEAN DISTRIBUTION ON ENVIRONMENTAL PERFORMANCE

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Abstract

Lean Distribution is a strategic and operational approach to logistics management aimed at optimizing the efficiency and effectiveness of product flows while minimizing waste. This approach focuses on reducing lead times, inventory, and costs, all while improving quality and customer satisfaction.

In a context of growing concerns about the environmental impact of human activities, environmental performance becomes a critical priority for businesses worldwide. In this regard, combining Lean Distribution with environmental performance shows promising potential. By streamlining processes, minimizing waste, and optimizing resource management, Lean Distribution can significantly contribute to reducing the ecological footprint of supply chains and distribution. This synergy presents a unique opportunity for businesses to reconcile their economic objectives with their environmental responsibility.

In this study, we will conduct an in-depth analysis of existing literature to identify and categorize the most significant lean practices in the downstream of the supply chain. We will also seek to establish clear links between these lean practices and three environmental performance indicators.

Keywords: Lean distribution, supply chain, environmental performance

Introduction

Over the past decade, competition between organizations has become a question not only of productivity, but also of overall supply chain performance (Li et al, 2005). And to survive in the current market situation, the company must have lower product prices, less inventory, rapid customer response and good product quality. Finding non-value-added activities in all sections of the organization and eliminating them has been the strategy for satisfying customers and surviving in today's market.

The quest to deliver high levels of service to customers, while retaining an attractive profit margin, has forced managers to think of new ways to eliminate waste from their internal operations. Lean thinking is one of the most effective techniques managers can use in this ambition.

This technique is now increasingly applied to all areas of the organization, from sales and marketing to engineering and production, finance and after-sales service.

Extending Lean thinking beyond manufacturing to distribution improves responsiveness to customer demand at minimum cost, which in turn offers a major competitive advantage for supply chains (Reichhart and Holweg 2007).

Conjointly, environmental sustainability is today a strategic imperative for organizations,which must be aligned with their traditional priorities of profitability and efficiency (Garza- Reyes, 2015).

Lean distribution and environmental performance has attracted the interest of researchers, many of whom have studied the possible relationships between the adoption of lean distribution practices and environmental performance.

In fact, the aim of this article is to look at the downstream supply chain and determine whetherlean practices will have an impact on the various measures of environmental performance.

Consequently, this article aims to review the existing literature, identify and classify the most important lean practices at the downstream level of the supply chain, and clarify the relationships between lean practices and the three measures of environmental performance.

To this end, this research paper is divided as follows: Section 2 presents a literature review. Section 3 illustrates the research methodology followed. Results and discussion are presented in Section 4, while Section 5 offers a summary conclusion and directions for future research.

Literature review

The distribution process

The role of distribution in the supply chain management model has expanded considerably from the conventional view of the business as being concerned solely with transport and warehousing. The distribution function assumes a broader role as a supplier of final added value. Distribution in the integrated supply chain has become a value-added activity, providing an essential link between the customer and the factory. - (Kirk D.Zylstra, 2006)

The distribution process refers to the methods and activities involved in bringing a product or service from the manufacturer or supplier to the end user or consumer. It includes all stages from initial production to final delivery of the product to the customer.

This process usually involves a chain of intermediaries, including wholesalers, distributors and retailers, who play different roles in distribution. These intermediaries help to move products efficiently from the manufacturer to the end customer. (Park, Y. B, 2005)

Distribution is an essential part of the supply chain, and can have a significant impact on a company's success. Efficient and effective distribution can help a company improve customer satisfaction, increase sales and reduce costs, while inefficient distribution can lead to lost sales, lower profitability and damage to a company's reputation. (Hou et al, 2017)

The evolution of distribution processes challenges distribution optimization and the organization's ability to meet performance targets. Distribution strategies, warehouse locations, service levels and operations have been built around this role, resulting in many of the facilities, business processes, technologies and policies in use today (Lummus et al, 1999). Traditional distribution functions have come under attack as the business environment and competition evolve. Sales channels have expanded with the addition of online merchants, and other drop-ship channels have increased order rates, reduced quantities per order and altered the mix of outbound transport. Competition is changing the traditional role of distribution, as customers are more successful in reducing prices and obtaining stricter service policies. Improving distribution processes is now a prerequisite for survival in today's commercial market (Tan et al, 2001).

Lean supply chain management

The application of lean in operations optimization is broad. Recent research studies have reported successful implementations in a diverse range from service to pure material- dominant operations (El-khalil et al, 2022; Sunder et al, 2018). More recently, many researchers have studied the implementation of lean management principles in various supply chain contexts.

Argiyantari et al (2020) highlight the need for a roadmap, showing how to implement lean principles in the pharmaceutical industries. Salah and Rahim (2019) discuss a synergistic effect achieved through the integration of lean and six sigma principles in supply chain management (SCM). Al-Aomar and Hussain (2019) study the implementation of Lean principles to enhance hotel supply chain capabilities. They find that among six categories of Lean techniques and tools, the adoption of just-in-time practices is the most effective category in the hotel industry. In addition, some researchers with more conceptual orientations are investigating models to comprehensively capture lean practices in supply chain contexts (Moyano-Fuentes et al., 2021).

The logistics part of a supply chain is another interesting area for empirical and theoretical research studies. Balvin et al (2020) use lean and six sigma principles to supply natural gas to highland locations. Frontoni et al. (2020) report on the results obtained by implementing lean principles and industry 4.0 principles in a shipping company.

Lean distribution

The Lean philosophy (Lean Thinking, Lean Manufacturing or Toyota Production System) was developed by the Japanese in the mid-1950s and is now used by companies worldwide. The term "Lean Thinking" encompasses a range of Lean practices and was first proposed by Womack et al. (1992). The aim was not only to eliminate waste and excess production, but also to generate value for the customer for which he is willing to pay. As such, it is applied in many industries. The main benefits of implementing Lean are reduced costs, improved quality and enhanced customer service (Piercy & Rich, 2008). The concept proved to be a great success and later became a standard in industries such as automotive, aerospace and IT (Honda, General Electric, Boeing, Helwett Packard, IBM, Zara, Amazon, etc.). Lean is in fact a philosophy based on six principles: elimination of waste, broad vision, simplicity, continuous improvement, visibility, flexibility. Particular emphasis is placed on eliminating waste, where waste is anything that does not create value (Sanders, 2014).

At the strategic decision-making level, Lean refers to an increase in value, while at the operational level, it involves a range of techniques and tools. Some of the most important tools used by Lean are : Kaizen, Pull System or Kanban, Taguchi Method, 5S, JIT (Just-in- time), Poka Yoke, TPM (Total Productive Maintenance).

The concept of Lean distribution emerged along with its predecessor - Lean Manufacturing, in the automotive industry (Toyota, Japan) as an approach to managing large, complex supply chain networks in order to reduce costs and deliver high quality (Faccio et al, 2013).

Lean distribution is the "pull" expansion of demand signals between the factory and the end customer, meaning that goods are only produced at the factory when the customer requests them (Reichhart and Holweg, 2007). In addition, according to Jaca et al. (2012), the lean concept in "distribution" is the reduction of waste and redundant means of transport, while maintaining the high quality of customer services. As there are always, products that customers are reluctant to wait for, lean distribution cannot be seen as stockless distribution or a distribution system based on orders (Reichhart and Holweg, 2007).

Companies able to fully implement a set of lean distribution methods and techniques can achieve significant performance improvements (Mahfouz and Arisha, 2013).

Lean distribution practices and environmental performance

Humanity today faces major challenges in the form of natural resource scarcity, climate change and environmental degradation. And to support environmental sustainability by developing better strategies, the implementation of lean practices appears to be the optimal solution to meet environmental challenges and sustainability requirements.

In this context, many researchers have discussed the effects that lean methods and tools can have on the environment. According to King et al, 2001, Lean can reduce pollution costs. Their hypotheses were confirmed by the results of their 1991-1996 studies of a number of American companies: Lean has a positive impact on environmental practices. Chiarini (2014) analyzed five European companies producing motorcycle components and using Lean and environmental management. The environmental impacts of the five companies' production processes were observed and assessed before and after the implementation of Lean tools: Value Stream Mapping (VSM), 5S, cellular manufacturing, Single Minute Exchange of Dies (SMED) and Total Productive Maintenance (TPM). Examination of the quantitative results shows that: VSM is used to map the environmental impact of production processes. 5S can help reduce oil leaks and improve waste management. Cellular manufacturing will reduce electricity consumption. In addition, TPM can help reduce many of the impacts of machinery, such as oil leaks, dust emissions and chemical fumes in the environment.

Mollenkopf et al (2010) argue that lean companies are more likely to embrace environmental innovations. Garza-Reyes (2015) supports this argument, stating that lean's focus on waste reduction provides a better atmosphere for implementing green initiatives aimed at reducing environmental waste such as excessive consumption of water, energy or any natural resource.

For Carvalho et al (2011), some of lean's waste reduction objectives are "naturally" aligned with good environmental practice.

For example, unnecessary or excessive transport of products and/or raw materials is one of the seven wastes addressed by the Lean approach.

In this case, when this waste is reduced/eliminated, it not only minimizes operational costs, but also unnecessary consumption of natural resources (e.g. oil) and CO_2 emissions.

This was demonstrated empirically by Garza-Reyes et al. (2016), who successfully adapted lean manufacturing principles and tools to improve the operational efficiency and environmental performance of the transport operations of a leading global logistics organization in Mexico.

Research methodology

The main objective of this research is to study the impact of Lean Distribution and its practices on environmental performance. Thus, and within the framework of supply chain management and its link with environmental performance, a literature review on implemented lean practices was carried out using different databases.

Extracting the lean practices used in supply chain management was the first step, and then, in order to identify the impact of these practices on environmental performance, we focused on studies that specified the practices that directly influence the measurement of the environmental aspect. To this end, several steps were followed, developed as follows:

1. Research objective: identify and classify lean practices, and clarify the impact of these practices on environmental performance.

2. Key words used: Lean, Supply chain management, Sustainable performance, Sustainability, Environmental performance.

3. Inclusion criteria: Qualified international scientific publications (journal articles and conference proceedings), in English, on the adoption of lean supply chain management practices in an integrated way and analyzing the impact on one or more aspects of sustainable performance.

4. Exclusion criteria: Books, reports, essays and theses have all been excluded.

5. Documentary research: Searches on electronic databases: Scopus, Emerald, Science Direct (Elsevier), Web of Science. We also did additional research on Google Scholar.

6. Data extraction: 17 articles were selected for review

7. Summary and added value: The creation of two summary tables: the first lists lean practices according to the frequency with which they are cited in the literature. The secondfocuses on the impact of these practices on environmental performance through three measures: environmental costs, Life-cycle assessment (LCA) and business waste.

Results and discussion

Classification of lean practices :

Table 1 shows the main Lean practices used in supply chain management. A number of 33 practices were collected from the literature. On the basis of citation frequency, "Just in time" is the lean practice most identified in previous research, with a frequency of 12, followed by Total productive maintenance (TPM) with a frequency of 7, and Total quality management (TQM) and Value stream mapping (VSM) with a frequency of 5 articles.

Table 1: Classification of lean practices

Lean Practices	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Frequency
Six sigma	X													X			X	3
Just in time			X		X	X	X	X	X	X	X	X	X			X	X	12
Supplier relationships			X								X	X						3
5S					X	X								X	X			4
Statistical process improvement					X													1
SMED					X										X			2
Visual control/workplace					X													1
Milk run or circuit delivery for smaller distances													X					1
Kanban					X										X		X	3
Cross-docking or compound delivery approach for great distances													X					1
High average utilization rate							X			X								2
Perfect customer order rates		X																1
Overall equipment effectiveness (OEE)					X													1
Employee involvement /commitment					X													1
Supplier networks /development					X													1
Value stream mapping (VSM)					X	X								X	X		X	5
Push flow system				X														1
Cellular manufacturing					X	X											X	3
Inventory minimization							X			X								2
Delivery performance improvement													X					1
Shorter lead times							X			X								2
Information spreading through the network							X											1
Total productive maintenance (TPM)					X	X					X			X	X	X	X	7
Vendor Managed Inventory								X					X					2
Kaizen					X	X									X		X	4
Cycle/setup time reduction			X								X	X						3

Order/shipment tracking/notice													X					1
Customer relationships											X		X			X		3
Total quality management (TQM)					X				X		X			X		X		5
Lote size reduction											X							1
Flow layout															X			1
Work standardization					X													1
Visual management															X			1

References: 1- Gultom et al, 2019; 2- Tendayi et al, 2012; 3- Azevedo et al, 2011; 4- Erraoui et al, 2022 ; 5- Kosasih et al, 2022 ; 6- Louhelainen, 2021 ; 7- Carvalho et al, 2011 ; 8- Ugarte et al, 2016 ; 9- Govindan et al, 2015 ; 10- Carvalho et al, 2011 ; 11- Azevedo et al, 2011 ; 12- Azfar et al, 2014 ; 13- Carvalho et al, 2010 14- Azevedo et al ; 15- Dieste et al, 2020 ; 16- Singh et al, 2020 ; 17- Parveen et al, 2011.

The impact of lean practices on environmental performance:

The relationships between lean practices and environmental performance are presented in Table 2, linking each practice to the environmental performance measure. These results are useful for identifying the impact of each practice on each of the environmental performance measures within supply chain management.

In fact, out of a total of 33 practices, 14 contribute to reducing environmental costs: milk run, kanban and cross-docking. As for Life cycle Assessment (LCA) - a technique for evaluating the environmental impacts associated with all stages in a product's life, from the extraction of raw materials to the processing, manufacture, distribution and use of materials - 9 practices contribute to this measure, namely Six sigma, 5 S, Value stream mapping (VSM), Cellular manufacturing, Total productive maintenance (TPM), Kaizen, Cycle/setup time reduction, Lote size reduction and Work standardization. The last measure of environmental performance is business waste, which is presented by 10 practices including Just in time, Supplier relationships, SMED and Visual management.

Table 2. The impact of Lean practices on environmental performance

Lean practices	Measuring environmental performance		
	Environmental costs	Life-cycle assessment (LCA)	Business Waste
Six sigma		x	
Just in time			x
Supplier relationships			x
5S		x	

Statistical process improvement	x		
SMED			x
Visual control/workplace	x		
Milk run or circuit delivery for smaller distances	x		
Kanban	x		
Cross-docking or compound delivery approach for great distances	x		
High average utilization rate			x
Perfect customer order rates			x
Overall equipment effectiveness (OEE)	x		
Employee involvement /commitment			x
Supplier networks /development	x		
Value stream mapping (VSM)		x	
Push flow system	x		
Cellular manufacturing		x	
Inventory minimization	x		
Delivery performance improvement	x		
Shorter lead times	x		
Information spreading through the network			x
Total productive maintenance (TPM)		x	
Vendor Managed Inventory	x		
Kaizen		x	
Cycle/setup time reduction		x	
Order/shipment tracking/notice	x		
Customer relationships			x
Total quality management (TQM)	x		
Lote size reduction		x	
Flow layout			x
Work standardization		x	
Visual management			x

Conclusion

In conclusion, it is clear that lean distribution plays an essential role in improving the environmental performance of supply chains. Our results show that adopting lean principles leads to significant gains in terms of environmental costs and business waste. By optimizing logistics processes and fostering close collaboration between the various players in the supply chain, lean distribution helps to minimize delivery times, transport costs and the quantities of waste generated, thereby helping to preserve the environment and reduce negative impacts on ecosystems.

Furthermore, this study highlights that lean distribution is not simply a cost-cutting strategy, but a comprehensive approach to promoting the responsible and sustainable management of resources. By integrating environmental concerns into their planning and decision-making processes, companies can not only save money, but also reinforce their brand image as socially responsible players concerned about the future of our planet. The aim of this research paper is to review the existing literature in the field of supply chain management and to study the impact of lean practices on environmental performance. This research will benefit researchers in the same field, as it has identified the various lean practices in distribution and even clarified the relationship and contribution of these said practices and the three measures of environmental performance. Nevertheless, it is important to stress that the successful implementation of lean distribution requires a strong commitment from management and the active involvement of all employees. Organizational and cultural obstacles may arise, but with a long-term vision and appropriate incentives, companies can overcome these challenges and reap both the economic and environmental benefits of lean distribution. This research highlights the significant potential of lean distribution to improve the environmental performance of supply chains. By adopting this approach, companies can make a tangible contribution to combating climate change and preserving our planet, while improving their operational efficiency and competitiveness in the marketplace. Therefore, it is vital that industry players consider lean distribution as an essential strategy for creating a sustainable and prosperous future for generations to come.

Finally, we would like to point out that the results of this article are based on previous empirical studies. And given the existence of a very large number of lean distribution practices that have not been empirically tested in terms of their impact on environmental performance, future research activity is needed to study the actual links, overlaps, advantages and disadvantages, positive impacts and even gaps, in order to identify other Lean practices that could be advantageous for improving sustainability.

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