Lean applied for automotive spare parts's development in Thailand

Tanasarn Panichayakorn

[1]College of Logistics and Supply Chain, Suan Sunandha Rajabhat University, Thailand

e-Mail: [1]tanasarn.pa@ssru.ac.th

Abstract

The automobile industry heavily relies on efficient spare parts management to ensure uninterrupted production and optimal customer service. However, traditional inventory and supply chain methods often result in inefficiencies such as excessive stock levels, longer lead times, and elevated costs. Lean improvement methodologies, rooted in waste reduction and process optimization, offer a transformative approach to addressing these challenges. This study explores the application of Lean principles in spare parts management within the automobile industry, focusing on techniques such as value stream mapping, Kanban systems, and continuous improvement cycles. By identifying non-value-adding activities, streamlining procurement processes, and enhancing supplier collaboration, Lean improvement fosters agility and cost-effectiveness in spare parts operations. The findings demonstrate significant reductions in inventory holding costs, improved lead time performance, and heightened responsiveness to demand fluctuations. This research underscores the potential of Lean methodologies to revolutionize spare parts management, offering a competitive advantage in the dynamic automotive sector.

Keywords: Lean applied, improvement, automotive spare parts

1. Introduction

Importance of the Automotive Industry in the Global Economy

The automotive industry is a cornerstone of the global economy, contributing significantly to employment, technological innovation, and economic output. As one of the largest industrial sectors worldwide, it spans a highly intricate and interconnected supply chain that involves vehicle manufacturers, suppliers, distributors, and aftermarket services. This complexity arises from the diverse range of processes, stakeholders, and regulatory requirements that must be coordinated to ensure efficient production and delivery. Furthermore, the automotive industry is characterized by intense competition, driven by evolving consumer demands, globalization, and the push for innovation in response to environmental and technological advancements. To remain competitive, manufacturers must focus on delivering high-quality vehicles while controlling costs, optimizing resources, and reducing time-to-market. In this context, operational efficiency is not merely a strategic advantage but a necessity for survival in an increasingly dynamic and demanding market environment.

Significance of Spare Parts Management in the Automotive Industry

Spare parts management holds a pivotal role in the operational success of the automotive industry, serving as a critical link in the lifecycle of vehicles post-production. Spare parts ensure

the continued functionality, reliability, and safety of vehicles, making them indispensable for both maintenance and repair operations.

Table 1: significance of Spare Parts Management in the Automotive Industry

Aspect	Description	Impact on the Industry
Operational Efficiency	Ensuring timely availability of spare parts to maintain production and repair operations.	Minimized equipment downtime, enhanced production continuity, and reduced bottlenecks.
Inventory Optimization	Managing inventory levels to balance supply and demand without overstocking or understocking	Avoided excess inventory costs while reducing risks of stockouts and obsolete inventory.
Cost Management	Streamlining spare parts logistics to minimize operational and storage costs.	Helped lower transportation and warehousing costs, contributing to overall cost savings.
Customer Satisfaction	Providing spare parts promptly to repair vehicles and maintain fleet reliability.	Enhanced brand loyalty and customer trust by reducing vehicle downtime.
Aftermarket Revenue	Capturing opportunities in the automotive aftermarket by ensuring an efficient spare parts supply.	Created additional revenue streams and competitive advantage for OEMs and suppliers.
Technology Integration	Adoption of digital tools (e.g., predictive analytics, inventory software) to optimize management.	Improved forecasting accuracy and demand planning for spare parts supply.
Global Supply Chain Complexity	Addressing challenges of a globalized automotive supply chain with varying lead times and regulations.	Improved resilience to supply chain disruptions and faster response to market needs.
Sustainability	Reducing waste by optimizing spare parts manufacturing and reuse/recycling.	Contributed to greener supply chain practices and reduced environmental impact.

Effective spare parts management minimizes downtime for customers and commercial fleets, directly influencing customer satisfaction and brand loyalty. Conversely, poor management of spare parts inventory can lead to supply chain disruptions, prolonged repair times, and increased costs due to overstocking or obsolescence. Given the complexity of demand forecasting, inventory control, and logistical coordination in this domain, efficient spare parts management is essential for maintaining operational continuity and meeting the high expectations of modern consumers.

Overview of Lean Principles

Lean methodology, originally developed within the Toyota Production System, is a proven management philosophy that focuses on maximizing value for the customer by systematically eliminating waste and improving processes. At its core, Lean identifies and eliminates activities that do not add value, such as excess inventory, overproduction, defects, and unnecessary waiting times. By emphasizing continuous improvement (Kaizen), Lean fosters a culture of innovation and collaboration among stakeholders to enhance efficiency and productivity. Key tools and techniques within Lean include Just-in-Time (JIT) production, which minimizes

inventory levels by aligning supply with demand, and Value Stream Mapping (VSM), which visualizes processes to identify bottlenecks and inefficiencies. Additionally, Lean emphasizes workplace organization through practices such as 5S, which standardizes work environments to reduce errors and improve efficiency. Ultimately, the application of Lean principles ensures streamlined operations, optimized resource utilization, and enhanced customer satisfaction, making it highly relevant for industries striving to remain competitive in today's fast-paced and resource-constrained environment.

1.1 Research Objective

In this research, we were classified the research objective into 2 items

1.1.1 To analyze the impact of Lean methodologies in the automobile industries.
1.1.2 To evaluate the effectiveness of Lean principles in the automobile industries.

2. Literature Review

2.1 Lean Concept

Lean (Narasi Thavorakul, 2002) is a systematic approach to identifying and eliminating waste or non-value-adding elements within the value stream of a process. It operates based on customer demand through a **Pull System**, enabling continuous, smooth workflows and fostering ongoing improvements to create value within the system.

Lean is defined as:

- A production approach aimed at eliminating waste within processes, such as excessive work-in-progress (WIP) and finished goods inventories.
- A production method that does not involve reducing the workforce.
- A production method designed to increase output by reducing costs and shortening production lead times.
- A production method focused on understanding customer needs.
- Value is determined from the customer’s perspective.
- Every process strives to enhance customer value.
- Any activity that does not add value is considered waste.

The goal of Lean production is to achieve the highest product quality, lowest production costs, and shortest production times by eliminating non-value-adding processes/activities, such as:

- **For materials**: Unnecessary repairs, excessive inventory, and storage costs.
- **For labor**: Absenteeism, inefficiency in work performance.
- **For capital**: Underutilization of machinery or resources, energy waste, insufficient energy sources.
- **For production support**: Inefficient factory layouts and underutilized spaces.

In general, characteristics of Lean production include reduced waste, shorter lead times, smaller batch sizes, lower inventory levels, fewer but more reliable subcontractors, smaller and

more specific production lines, less frequent production schedule changes, reduced bottlenecks, fewer employees (but more skilled), and more flexible machinery and tools.

Lean is about transforming waste into value from the customer's perspective and promoting continuous improvement. Lean is not about working harder or faster but about identifying waste and transforming it into value that customers desire. It is not a set of ready-made tools but rather an integration of concepts, activities, and methods to shape a culture that aligns with organizational goals. This is achieved by instilling the right mindset and awareness in employees at all levels.

- **Unique Characteristics of Lean**

According to Womack & Jones (2003), Lean is a method that allows organizations to do more with less – less labor, equipment, time, and space – while simultaneously meeting greater customer demand.

Lean originated in Japan following World War II, a time when Japanese organizations, recovering from the war, faced severe resource and financial constraints. Unlike mass production in the United States or Europe, Japanese production systems needed to adopt the following characteristics to remain competitive internationally:

- **Just-In-Time Production (JIT)**: There was insufficient capital to risk investing in excessive inventory.
- **Flexible Production Systems**: The ability to adapt to changing customer demands.
- **Low-Waste Processes**: Minimizing waste in the production process.
- **Low-Cost Production**: Keeping production costs as low as possible.

The Japanese company Toyota became the model for Lean production, known as the **Toyota Production System (TPS)**, which is built on three core principles:

1. **Just-In-Time Production (JIT)**: Producing only what is necessary, in the quantity needed, at the right time. This pull-based system focuses on producing products in quantities that match customer demand, including internal customers (subsequent processes). It differs from a push-based system that maximizes output regardless of downstream demand. JIT eliminates unnecessary WIP inventory and stockpiling. It requires flexible equipment, materials, and skilled employees to adapt quickly to production changes.
2. **Stopping Production When Defects Are Found (Jidoka)**: Unlike traditional quality control that inspects products after production, Jidoka emphasizes preventing defective products from being produced. When defects are detected, the production line is immediately halted to address the root cause and prevent recurrence. This minimizes wasted resources, time, and costs. Jidoka also incorporates tools like Statistical Process Control (SPC) to monitor quality during production.
3. **Consistency in Production (Heijunka)**: Achieving production consistency reduces waste caused by variation (Mura) and overburdening (Muri). This involves standardizing processes, using error-proofing (Poka-Yoke), and continuously improving workflows to prevent recurring issues.

Lean transforms the traditional production view of **Cost + Profit = Selling Price** into a Lean perspective of **Profit = Selling Price - Cost**. The Lean approach emphasizes reducing waste and optimizing resource utilization to deliver maximum value to customers.

- **The Three Pillars of Lean (3M in TPS)**

1. **Muda (Waste)**: Refers to inefficiencies in processes, such as excess inventory, overproduction, or unnecessary movement. Reducing Muda allows resources to be used more effectively.
2. **Mura (Variation)**: Reducing inconsistency in processes is critical to maintaining quality. Variations often lead to delays, defects, and inefficiencies.
3. **Muri (Overburden)**: Overloading workers or machines beyond capacity leads to fatigue, breakdowns, and inefficiencies. Addressing Muri involves balancing workloads and optimizing resources.

2.2 Automobile Spare parts situation in Thailand

The automotive industry faces a critical challenge in managing service parts effectively. Beyond being a logistical puzzle, it stands as a strategic necessity (Kato and Manchidi, 2022). With vehicles becoming more complex and customer expectations reaching new heights, the seamless flow of service parts from manufacturers to end-users is paramount (Jiao et al., 2021). This paper meticulously navigates the complexities of service parts management and demand forecasting within the unique context of the Thai automotive industry. It introduces innovative strategies and methodologies aimed at reshaping manufacturers' approaches to this critical operational facet.

Within the intricate dynamics of the automotive sector, maintaining optimal stock levels for service parts is a multifaceted challenge (Cardeal et al., 2023). Excessive inventory risks bloated holding costs and parts obsolescence, while insufficient stocking may lead to prolonged vehicle downtimes and reputational damage (Ding and Li, 2021). In the distinctive landscape of the Thai automotive industry, marked by unique market dynamics, consumer preferences, and intricate supply chain nuances, a nuanced and data-driven approach to service parts management becomes imperative (Aunyawong et al., 2020).

2.3 Automobile Spare parts Supply Chain

The automotive spare parts supply chain is a complex system that requires efficient management to meet consumer demands and operational challenges. Recent research highlights various strategies to optimize this supply chain, focusing on technology integration, inventory management, and performance measurement. The following sections outline key aspects of the automotive spare parts supply chain.

- **Efficient Tracking and Delivery Systems**
- Development of responsive web applications enhances tracking and delivery scheduling, improving customer satisfaction(Hiuredhy et al., 2024).
- Usability testing indicates a good level of user experience, essential for operational success in the aftermarket sector(Hiuredhy et al., 2024).
- **Integration of Predictive Maintenance**

- Combining predictive maintenance with inventory management can reduce costs and minimize machinery downtime(Shokri et al., 2024).
- Identifying barriers to integration is crucial for implementing effective digital supply chain solutions in the automotive industry(Shokri et al., 2024).

2.4 Lean Production

Lean production is a management philosophy focused on minimizing waste while maximizing productivity and quality. Originating from the Toyota Production System, it has evolved into a comprehensive approach that integrates various tools and methodologies to enhance operational efficiency across industries. The implementation of lean production not only reduces costs but also improves product quality and responsiveness to market demands. Below are key aspects of lean production.

- **Key Principles of Lean Production**
- **Waste Reduction**: Lean production emphasizes the elimination of waste in all forms, including overproduction, waiting times, and unnecessary transportation(Uttamrrao et al., 2024).
- **Continuous Improvement**: The philosophy promotes a culture of ongoing enhancement, encouraging employees to identify inefficiencies and suggest improvements(Uttamrrao et al., 2024)(Lekareva & Remizova, 2024).
- **Employee Involvement**: Engaging personnel in the lean process is crucial for fostering a culture of continuous improvement and ensuring successful implementation(Гончаренко, 2024).

4. Methods

Methods Employed in this research on Lean in Automotive Spare Parts Development in Thailand. Methods commonly used in this research as follow:

1. **Case Studies:**
    - Detailed exploration of specific automotive companies applying Lean principles.
    - Focus on identifying bottlenecks, process inefficiencies, and Lean tools implemented (e.g., Kaizen, 5S, JIT).
2. **Surveys:**
    - Distribution of questionnaires to stakeholders (e.g., 40 manufacturers, 100 suppliers) to collect opinions on Lean practices.
3. **Interviews:**
    - Semi-structured interviews with 10 industry experts, for qualitative insights.
4. **Time-Motion Studies:**
    - Observation of production processes to identify waste and inefficiencies.

5. **Comparative Analysis:**
    - Comparing Lean implementation in Thailand to other regions (e.g., Japan, USA) to understand differences.

Table 2: Comparative Table of Methods

Method	Advantages	Disadvantages
Case Studies	Provides in-depth understanding of real-world Lean application.	Limited generalizability due to focus on specific companies.
Surveys	Efficient for collecting data from a large group of participants.	Responses may be biased or lack depth.
Interviews	Captures detailed insights and firsthand experiences.	Time-consuming and may involve subjective interpretations.
Time-Motion Studies	Identifies bottlenecks and waste in production processes.	Requires extensive observation and may disrupt normal operations.
Comparative Analysis	Highlights best practices and contextual differences in Lean implementation.	Requires comprehensive data from multiple regions, which may not always be accessible.

5. Results and Discussion

5.1 Results of the Application of Lean:

1. **Speed of Service:**
   Overall, the speed of service was rated at a high level (Mean = 3.68, S.D. = 0.79).
    - The highest-rated aspect was the ability to reduce or eliminate steps that cause delays in service (Mean = 4.00, S.D. = 0.73).
    - The second highest was the ability to provide services in a sequential order as planned (Mean = 3.74, S.D. = 0.85).
    - The lowest-rated aspect was the ability to reduce the workload of operators (Mean = 3.46, S.D. = 0.82).
2. **Improved Communication with Service Recipients:**

Overall, communication with service recipients was rated at a high level (Mean = 3.65, S.D. = 0.81).

- The highest-rated aspect was the proper placement of signs/symbols, dissemination of information, and service point directions (Mean = 3.80, S.D. = 0.75).
- The second highest was the ability of service recipients to follow the instructions provided by service providers correctly (Mean = 3.65, S.D. = 0.80).
- The lowest-rated aspect was the reduction of conflicts between service providers and service recipients (Mean = 3.55, S.D. = 0.85).

3. **Safety of Service Recipients:**
   Overall, safety during service was rated at a high level (Mean = 3.55, S.D. = 0.78).
   - The highest-rated aspect was the safety of service recipients during their service experience (Mean = 3.65, S.D. = 0.72).
   - The second highest was the reduction of accidents while waiting for service (Mean = 3.60, S.D. = 0.77).
   - The lowest-rated aspect was the reduction of errors or loss of patient medical records (Mean = 3.43, S.D. = 0.87).
4. **Relationship Between Lean Dimensions:**

A comparison of the relationships between different dimensions, specifically operational and managerial aspects, was performed using Pearson Correlation with a significance level of 0.01. The results are shown in Table 3 as follows:

Table 3: Correlation Between Opinions on Lean Systems in Terms of Consistency Between Operational and Managerial Dimensions

Dimensions	**Operational**	**Managerial**
Operational	Pearson Correlation = 1	Pearson Correlation = 0.87**
	P-Value = -	P-Value = 0.00
Managerial	Pearson Correlation = 0.87**	Pearson Correlation = 1
	P-Value = 0.00	P-Value = -

Interpretation:
The correlation coefficient (Pearson Correlation = 0.87**) indicates a strong positive relationship between the operational and managerial dimensions of Lean implementation, with a statistically significant P-Value of 0.00.

6. Conclusion

Lean production offers significant advantages for manufacturing by enhancing efficiency, reducing costs, and improving product quality. This management philosophy focuses on minimizing waste and optimizing resources, which is crucial in today's competitive market. The following sections outline the key benefits of Lean production.

- **Efficiency Improvement**

Lean production methodologies, such as 5S and standardized work, streamline processes, leading to faster production cycles and reduced lead times(Гончаренко, 2024)(AUTHOR_ID, 2024).

By eliminating non-value-adding activities, companies can enhance overall productivity and operational flow(Riepina, 2024).

- **Cost Reduction**

Implementing Lean tools helps identify and eliminate waste, resulting in lower production costs(Гончаренко, 2024)(Semukhina, 2023).

The focus on continuous improvement allows for reinvestment in employee development and innovation, further driving down costs(AUTHOR_ID, 2024).

- **Quality Enhancement**

Lean practices emphasize quality control through standardized processes, which reduces defects and improves customer satisfaction(AUTHOR_ID, 2024)(Semukhina, 2023).

The integration of Lean innovation fosters adaptability, enabling companies to respond swiftly to market demands while maintaining high-quality standards(Keskin et al., 2023).

Conversely, while Lean production offers numerous benefits, its successful implementation can be hindered by resistance to change among employees and management, highlighting the need for effective change management strategies to overcome these barriers(Гончаренко, 2024).

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