

# Lean Production Implementation and Challenges among SMEs in China: A Review

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## Abstract

The increasingly growing competition in the market puts pressure on companies, especially Small and Medium-sized Enterprises (SMEs). Maintaining an efficient production system while producing constantly competitive products is a huge responsibility of SME managers. This review aims to describe the implementation of Lean Production among Chinese SMEs. Furthermore, it attempts to explore the challenges that hinder SME managers from fully implementing Lean Production in their respective enterprises. The study will employ literature review in consolidating existing studies on Lean production of SMEs. Using databases such as Google Scholar and Chinese National Knowledge Infrastructure (CNKI), the researcher grouped the studies thematically, and lastly identified the research gaps or future research perspectives which may be valuable to researchers who wish to have an exploration of the Lean Production among SMEs. The themes emerged from the analysis include Profile of Small and Medium Enterprises (SMEs) in the Chinese Context, Importance of Lean Production, Implementation of Lean Production, Challenges to the Implementation of Lean Production, Impacts of Lean Production to Operational Performance. There is substantial literature that explores the implementation of lean manufacturing among SMEs of different industries. However, only a few have explored the adaptation of Lean in Chinese SMEs, thus, there is a need for further exploration of this research gap.

**Keywords:** China, Lean implementation challenges, Lean practices, Lean principles, SMEs

## 1. Introduction

According to the data published by the National Bureau of Statistics of China (2023), in the year before the pandemic, China's monthly purchasing managers' index (PMI) hovered around 50%, with a maximum of 50.5% and a minimum of 49.2%. However, when the pandemic hit the country and the world, large-scale shutdown of companies has been observed, resulting to the country's PMI plummeted to 35.7%. In March 2020, after the government has contained the pandemic, Chinese companies started to resume their operations, the country's PMI remained in the boom range for 18 consecutive months, and continued to hover around 50% until September 2021. After Shanghai was closed in March 2022, the PMI dropped sharply from 49.5% in March to 47.4%, and then continued to hover around 50%, but since September, it has been declining all the way, at a rate of 1 percentage point per month, to the current 47%. The Purchasing Managers' Index (PMI) has been an important factor in predicting the strength of the country's economy, especially in describing the state of the manufacturing sector (Koenig, 2002). Thus, considering the data published by the National Bureau of Statistics of China, there is a need for the manufacturing sector to continuously adapt to the changing market situation to maintain its relevance and competitiveness. For instance, in the post-pandemic settings, Fokali & Siagian (2021) asserted that operational performance of

a company is indirectly influenced by the implementation of lean production. Among the aims of the lean production is the improvement of its internal processes to reduce production costs, reduce waste, improve products quality, and lastly, contribute to improving customer satisfaction.

Lean production is defined by Hosseini, Kishawy & Hussein (2015) as a business model that is designed to reduce waste in the production process. The Lean concepts seek to remove operations that use resources without producing any value. Reducing production waste contributes to lessening the production cost, thus making the final product more affordable. That is the reason why Gupta and Jain (2013) and Bhamu and Singh Sangwan (2014) regarded lean manufacturing as a business concept that aims to produce a high-quality product while making sure the customer's expense is kept to a minimum. Based on the definitions of Lean production, it can be said that it is an advanced management idea that can obtain higher productivity and profits, and at the same time improve the motivation of the staff and the cohesion of the enterprise, thus ultimately improving the level of the enterprise's operation and obtaining the sustainability of competitiveness. Since the early 1990s, lean manufacturing has been created by large corporations and used to improve production efficiency and cost savings and to achieve a good price advantage (Peterson, 2012; Rahman & Karim, 2013) However, despite the competitive advantage that lean production may bring, studies have shown that SMEs have not implemented lean production as widely as large companies. Some studies even suggest that there are certain challenges to the introduction of lean in SMEs, in addition to other factors such as culture, historical background, employee contracts, etc., which may also affect the implementation of lean.

Along with the full arrival of the information society, consumers can easily compare different brands of similar products, in which the price factor plays a crucial role in product sales, which puts forward higher requirements on the production management of production enterprises, not only requires enterprises to fast manufacturing, excellent manufacturing but also need to strictly control costs and enhance the price advantage. Based on this severe environment, China's manufacturing enterprise managers have also increased the importance of production management, put forward the optimization of production, shortened the lead time, and reduced cost measures. However, lean production is not something that can be implemented immediately and with good results if companies want to promote it. How SMEs can identify the challenges to the introduction of lean manufacturing and identify the challenges to implementation encountered in its process, has become the confusion and bewilderment of Chinese SMEs. Moreover, compared to bigger organizations, SMEs are less likely to adopt lean principles (Bakås, Govaert, & Van-Landeghem, 2011). Thus, Dorota-Rymaszewska (2014) emphasize the importance of evaluating SMEs' readiness to adopt Lean Production. Evaluation leads to early detection of challenges and weaknesses of the SMEs in implementing Lean Production, thus, contributing in further enhancing their readiness. In this paper, it is hoped that these challenges will be identified through a series of data collection and analysis, which will give Chinese SMEs some reference value.

## **2. Study Objectives**

### **2.1. General Objective**

The study aims to conduct a literature review related to the Lean production implementation and challenges among small and medium-sized enterprises (SMEs).

### **2.2. Theoretical Framework of the Study**

The Lean Production is anchored from the Theory of Constraints (TOC) conceived by Goldratt (1984). The Theory of Constraints serves as a framework for determining which constraint is the most significant

impediment to reaching a goal and for methodically removing it until it doesn't exist anymore. The theory advocates proactively eliminating constraints or restrictions to optimize performance and maximize profits. The TOC views the system as a chain of interconnected activities, and one of the activities can serve as the weakest link of the chain causing the decrease in the performance of the whole system and affecting its outputs. The constraints in the system can be physical, policy, paradigm, or even the market.

To improve the present constraint until it no longer limits the company's output, the Theory of Constraints (TOC) aims to give a precise and continuous focus, after which the next constraint comes into focus. The fundamental strength of TOC stems from its capacity to create intensely focused attention on a single objective—profit—and to eliminate the main obstacle—the constraint—that stands in the way of achieving more of that objective. To develop focused attention, the TOC suggests applying the five focusing steps which include: (a) identifying constraints, (b) exploiting resources to make quick improvement, (c) subordinating other related activities in the system, (d) elevating approach to solve the unresolved constraints, and (e) repeating the process to address other constraints. The whole-system approach helps the company to continuously improve its performance. After several decades since TOC was proposed, it is still regarded as one of the greatest strategies for companies (Simsit, 2014). Among the tools developed for the implementation of TOC is Lean Production.

### 3. Methods

To fully capture the adaptation of lean manufacturing among SMEs, this study employed a literature review. Studies were accessed through publicly available databases such as Google Scholar and Chinese National Knowledge Infrastructure (CNKI).

## 4. Review of Related Literature

### 4.1. Profile of Small and Medium Enterprises (SMEs) in the Chinese Context

Small and medium-sized enterprises (SMEs) account for 98.5% of all enterprises in China. The SMEs have a crucial impact on the country's economy because they contribute to over 60% of GDP, 50% of tax revenue, 75% of employment generation, and 68% of exports (Organization for Economic Cooperation and Development, 2024). Small and medium-sized enterprises have emerged as the driving forces behind China's economic growth (Zhang, 2009). The two major characteristics of Chinese SMEs include: (a) No external funds are raised. That is, no public issuance of stocks and bonds; and (b) Enterprises with smaller operating scales are small and medium-sized enterprises determined by the "Notice on Issuing Interim Provisions on Standards for Small and Medium-sized Enterprises" jointly issued by the four departments of the former National Economic and Trade Commission, State Planning Commission, Ministry of Finance, and National Bureau of Statistics.

To provide guidelines on the promotion of SMEs, the Ministry of Industry and Information Technology (2011) formulated the "Standard Regulations for Classification of Small and Medium Enterprises" issued through Ministry Order No. 300. The classification of Small, Medium, and Micro Enterprises is dependent on the institution's number of employees, operating income, assets, and other indicators. Furthermore, the classification is also industry-specific, thus, the nature of the industry is also an essential determiner. Among the industries identified by the country's standard regulation for classification include agriculture, forestry, animal husbandry, fishery, industry (including mining, manufacturing, electricity, heat, gas, and water production and supply industries), construction, wholesale, retail, and transportation.

In the context of this study, manufacturing companies will be targeted. Manufacturing companies are und-

er the industry classification. Under this classification, micro-enterprises are described as companies with less than 20 employees and operating income of less than 3 million yuan. On the other hand, a company will be considered a small enterprise if it has 300 or more employees and an operating income of 20 million yuan. Lastly, companies with 300 or more employees and an operating income of 20 million yuan or more are medium-sized enterprises.

It is of great importance to describe the profile of the target companies or firms of this study. Considering that the research locale is in China, there might be contextual variables that are significant in the implementation of lean manufacturing. According to Tortorella & Fettermann (2017), the association of contextual variables to lean production is essential and that influence of each variable may have its own extent. For instance, Marodin et al. (2016) asserted that company profile is an important variable to describe when exploring the implementation of lean production. The paper revealed that in terms of size or scale, larger companies tend to have a higher degree of implementing lean practices compare to smaller companies. Furthermore, maturity of lean practices depends on the profile of the company. This is supported with Mutua, Ngugi, & Odhiambo (2018) which claimed that the lean manufacturing positively influences the performance of large-sized manufacturing companies. In the context of Moroccan SMEs, though only 24% of the SMEs adopted lean practices, the following benefits were uncovered: (a) eliminating waste, (b) reducing cost, and (c) improving efficiency and production performance (Arabi et al., 2021). The literature put emphasis on the importance of contextual and demographic variables in the implementation of lean practices, thus, this study includes demographic variables to further contribute in the ongoing discussion.

#### **4.2. Importance of Lean Production**

The genealogy of the Lean Production was narrated by Womack, Jones, and Roos (1990) in the book titled “The Machine that Changed the World.” The Lean Production was described by the authors as a superior method to be used by humans in producing products because it offers more affordable, higher-quality items in a greater range. More importantly, it gives workers at all levels—from the factory to the headquarters—more demanding and satisfying employment.

However, the development of Lean Production commenced during the time of Eli Whitney, who introduced the idea of interchangeable parts, or the manufacturing of standardized parts. This concept allows for the replacement of only the dysfunctional part of a machine or equipment rather than reproducing the entire machine (Henry, 1982).

Another milestone in the development of Lean Production was contributed by Frederick W. Taylor, who shifted the focus from the machine to the workers and processes, and introduced a management concept called “Taylorism” or others refer to “Scientific Management.” According to Dave (2020), Taylorism resulted to reduction in process time, thus, enhancing efficiency. Based on the work of Taylor, Frank Gilbreth further improve the Lean Production by reducing workers’ movements and mapping the processes, resulting to well-defined process-flow and waste reduction (Iuga & Kifor, 2013).

In the context of adapting Lean Production in car manufacturing, Henry Ford has been famous for producing the “T-Model” Ford car for only 93 minutes (Michaela, 2015). The Ford has established a highly efficient production system centered around the concept of “Flow,” from raw materials to the customer's car. Ford pioneered several Lean principles, including standardization of product models and tasks, waste reduction by minimizing operator movements, and implementing a just-in-time supply chain to match materials with demand. However, Ford's system was criticized for its inflexibility, as it focused solely on producing a single product model without accommodating variations.

Post-World War II, Toyota faced economic hardships characterized by low demand and scarcity of spare parts, prompting further evolution in Lean practices. Emphasizing Jidoka, Toyota aimed to detect defects early to avoid repairs. Despite these advancements, productivity remained significantly lower than that of American car manufacturers, presenting ongoing challenges for Toyota. In the mid-20th century, during the peak of the U.S. automobile industry's development, Toyota, under the leadership of figures like Naichi Ohno, conducted a thorough analysis of American mass production methods. Facing their own challenges such as insufficient demand, technological lag, and capital limitations, Toyota integrated these insights with Japan's cultural ethos to pioneer a novel approach: a multi-mix, small-lot, high-efficiency, and low-consumption production method. Toyota's adaptation of Lean Production was popularly known as Toyota Production System or TPS (Gao & Low, 2013).

Lean production is described by Treville and Antonakis (2006) as a holistic manufacturing approach designed to optimize operational efficiency by reducing excess inventory and maximizing resource utilization. This is achieved by minimizing variability in factors such as arrival rates, processing times, and adherence to specifications within the production system. Buffer inventory of a particular operation can be considered as constraints, thus, limiting the optimization of the whole performance. This was supported by Pessôa & Trabasso (2016) which asserted that lean production encourages businesses to constantly identify and distinguish between customer-perceived value-adding and non-value-adding activities during the development and delivery of goods and services. Additionally, businesses should continually eliminate any activities that are deemed to be non-value-adding. The successful implementation of lean production can result in the elimination of waste, improvement of economic efficiency, optimization process, improve customer satisfaction, orderly working environment, cost reduction, enhancement of employee engagement, improved product quality, enhancement of data management and accuracy, and promotion of a culture of continuous improvement.

To achieve optimum results of Lean production, company managers may consider integrating the Five Lean Principles. The first principle suggests looking at the system from the customer's perspective to identify what is truly valuable for them. The second principle encourages continuous assessment of activities within the system to identify which contributes to the value and which contributes to the wastage. The third principle promotes streamlining of the process to be free of constraints that may delay the whole process. The fourth principle promotes alignment of products to the customers' demand and proactively adapts to changes in demand. The fifth principle promotes the development of cultures that pursue continuous improvement. By following the five lean production principles, companies can achieve customer satisfaction, reduced waste, increased productivity, an advantage over their competition, and, ultimately, larger profits.

### **4.3. Implementation of Lean Production**

In Sabah, Malaysia, Adzrie and Armi (2021) investigated the awareness of employees of drinking manufacturing SMEs towards the influence of lean manufacturing and revealed that it is correlated with their practices in Total Productive Maintenance (TPM) and Total Quality Management (TQM).

In the United Arab Emirates (UAE), Alefari et al. (2020) explored how leadership styles may influence the employees' performance of SMEs during the transition to lean manufacturing. To describe the leadership style, the study employed a survey questionnaire assessing the extent of the employee's understanding of lean manufacturing principles. It was revealed in the study that the level of understanding is a crucial factor in the success of lean manufacturing implementation. This highlights the importance of integrating the lean implementation within the local culture of the company, ensuring that the employees

are aware of its importance and main goal. Considering that the UAE has a context like that of the Arab countries, this paper can serve as a point of reference for the SMEs in the region when applying lean manufacturing.

In Peru, Alanya et al. (2020) explored the implementation of Lean Manufacturing to enhance the cutting process in a Textile SME. The reprocessing process was significantly minimized to 4.23%, which is 13.12% before the lean manufacturing implementation. Furthermore, delayed processes were reduced to 9.61%, which is almost half of the original 18.49%. Lastly, the productivity index tripled from 0.38 to 1.16, demonstrating the effectiveness of lean manufacturing. The same is reflected in Becerra-Guevara et al. (2020) which investigated the impacts of lean manufacturing in reducing the product development time of a Textile SME and revealed that lean has significantly reduced excessive work time, resulting in a 20% reduction rate. On the other hand, within the context of manufacturing SMEs, Francisco Henríquez-Alvarado et al (2019) explored the impact of lean manufacturing in reducing downtime. It was highlighted in the study that downtime was caused by uncleanliness and disorder. Through the use of value stream mapping (VSM), the most suitable approach to each activity of the system was identified, thus, improving performance as evidenced by the improved efficiency rate of 73%.

In addition, lean manufacturing implementation in the Peruvian metal-mechanic SMEs has been the subject of Reyes et al. (2023). The paper analyzed the impacts of Lean towards On-time In-full (OTIF). Through the implementation of lean, factory layout, procedures, and tools organization were enhanced, resulting in an increased OTIF with a value of 92.86% from the original 53.57%. The same is reflected in Quiroz Flores et al. (2023) examined the implementation of lean manufacturing in a metalworking SME and revealed that lean helps reduce defective outputs in the production line. This was supported by the data that shows a significant reduction of 16 percentage points in the defect rate. On the other hand, Arroyo-Huayta et al. (2020) explored the impacts of integrating lean manufacturing to the performance of the Extrusion area of Peruvian Industrial Plastic Manufacturing SME. Through the utilization of lean manufacturing tools such as SMED, 5S, and autonomous maintenance, the setup time and breakdown rates were reduced to 50%, while reprocesses were reduced by 60%. The study highlights the effectiveness of incorporating lean

Rojas-Benites et al. (2022) examined how lean manufacturing can help Meat SMEs in reducing waste. The findings emphasized that 8% of annual expenses of Meat SMEs are attributed to expired inventories caused by overproduction, immobilized products in-process, and oversupply of raw materials. To address the issues, the study used lean tools such as 5S, Standardization, Demand Forecasting, and Kanban, resulting in a 7% reduction in waste. This study proved that lean manufacturing can be used to reduce waste and contribute to enhancing SME profit. The same was reflected in Flores-Perez et al. (2023) which investigated the use of lean manufacturing of food SMEs to reduce excess waste. A total of four (4) models were introduced in this study, namely, systematic layout planning (SLP), 5S, TPM, and Standard Work. The implementation of SLP and lean manufacturing resulted in a 1.65% decrease in waste, thus contributing to lessening the SMEs' expenses.

Lopez-Osorio et al. (2022) employed Lean manufacturing in the context of Chemical Manufacturing SME. The study utilized a Value Stream Mapping tool to analyze the problems and identify possible root causes. Afterward, the study proposed a model which was then validated through Arena Simulator. In the simulation, it was revealed that the processing time, which includes filling and labeling of 200 kg cylinders, was more efficient, as evidenced by a 7.88% reduction in the processing time, 7.94% reduction in cycle time, and 8.48% increase in the productivity rate.

Cuadros-Lopez et al. (2023) integrated Lean manufacturing into the quality assurance system of a footwear SME. Guided by the goal of ensuring quality competitive products, the footwear SME integrated lean manufacturing. This resulted in the reduction of defective products and the development of a production system that is efficient and sustainable.

In the United Kingdom (UK), Choudhary et al. (2019) investigated the implementation of lean manufacturing, integrated with a green approach, of a Packaging SME to support its sustainable performance. Employing the Green Integrated Value Stream Mapping (GIVSM), it was revealed that lean manufacturing and green approach have been simultaneously contributing in both system efficiency and environmental performance. Furthermore, this study emphasizes the importance of establishing a continuous improvement framework that aligns lean manufacturing and green approaches to further maximize their advantages. The study serves as reference material for other industries that plan to integrate lean manufacturing and sustainability.

#### **4.4. Challenges to the Implementation of Lean Production**

Maware and Parsley (2022) investigated the challenges encountered by the 50 American manufacturing organizations in implementing Lean Production. Employing the fuzzy analytic hierarchy process (FAHP) and the fuzzy analytic network process (FANP), the organizations ranked the challenges manifested in the implementation of Lean Production. It was revealed that organizational culture was the major challenge to implementing Lean Production. Other challenges include support from the management, the need for additional technical knowledge, and overcoming resistance of employees to change. This was supported by Chan et al. (2019) which investigated Lean Production among manufacturing companies in Malaysia. It was revealed that workers' attitude or resistance is the major challenge that interrupted the adoption of Lean Production.

On the other hand, Lodgaard et al. (2016) identified challenges to the implementation of Lean Production from the different levels of the organization. It was revealed that top-level management faced challenges related to tools and practices in the implementation of Lean Production. On the other hand, ordinary workers identified management-related challenges in the adoption of Lean Production. Lastly, middle managers confirmed that practices and tools were not chosen and that there were no clearly defined roles and responsibilities for the implementation of Lean Production.

#### **4.5. Impacts of Lean Production to Operational Performance**

In the context of Brazilian automotive manufacturing, Marodin et al. (2017) investigated the relationship between the implementation of lean manufacturing practices and operational performance. The paper asserts that implementation of 11 Lean Manufacturing practices have resulted to reduced lead time and inventory, contributing to operational performance. This concurs with Uhrin, Bruque-Cámara, and Moyano-Fuentes (2017) which explored Spanish automotive manufacturing and asserted that implementation of lean manufacturing is influenced by workforce development, and that implementation of lean production increases employees' knowledge, which helps improving the operational performance outcomes of the company.

Rasi, Rakiman, and Ahmad (2015) examined the impacts of implementing lean production practices to operational performance from four lenses namely quality, delivery, cost and flexibility. The study uncovered positive relationship between the implementation of lean production practices to the four mentioned dimensions, thus, concluding that implementing lean production among manufacturing firms may result to improved operational performance. The same components of operational performance were examined by Hardcopf, Liu, and Shah (2021) and revealed that despite a significant reduction in cost

brought by the implementation of Lean Production, it requires an organization culture that is supportive in maximizing improvements in quality, delivery, and flexibility. It was recommended to promote a developmental culture of flexibility and adaptability to change, contributing in achieving superior operational performance.

Memari et al. (2024) examined the adoption of lean production principles of a Malaysian SME through process activity mapping (PAM) and uncovered a significantly reduced cycle time which in turn resulted to savings. Reduction in waiting times is essential in the promotion of the culture of continuous improvement in the production process. On the other hand, Rahman, Laosirihongthong, and Sohal (2010) employed multiple regression to explore the impacts of lean production on operational performance among SMEs in Thailand. The operational performance was quantified using delivery, unit cost of products, overall productivity, and customer satisfaction. It was revealed that lean production significantly correlated to operational performance.

## 5. Conclusion

There is substantial literature that explores the implementation of lean manufacturing among SMEs of different industries. However, only a few have explored the adaptation of Lean in Chinese SMEs, thus, there is a need for further exploration of this research gap. Furthermore, previous studies explored the effectiveness of lean adaptation by checking waste reduction and production efficiency, however, less attention was given to the perceptions of the people involved in deciding to adopt lean manufacturing. This study recommends exploration on how Chinese SME managers or owners perceive the implementation of Lean in their respective industries. Moreover, the study seeks to test the possible relationship between the SMEs' characteristics and managers' perceptions towards lean manufacturing. The implementation of the recommended study can contribute to further enriching the discussion on the adaptation of lean manufacturing among SMEs, specifically within the context of China. Lastly, the study can serve as a point of reference for SMEs who intend to have a preliminary understanding of lean manufacturing, and at the same time, to analyze how their characteristics may influence their decision to adopt lean manufacturing.

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