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Research on Operational Efficiency Improvement of Auto Parts Manufacturing Enterprises from the Perspective of Lean Management

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Abstract

Aiming at the common problems of chaotic production processes, excessive work-in-process inventory, and low equipment utilization in small and medium-sized auto parts manufacturing enterprises in China, this paper adopts the core lean management theory of industrial engineering, takes an auto chassis parts manufacturing enterprise in Sichuan Province as the research object, and applies lean tools including value stream mapping, 5S management, standardized operation, and quick die change to conduct systematic process optimization. The results show that after 6 months of lean management implementation, the production cycle of the enterprise's core product is shortened by 32.7%, work-in-process inventory is reduced by 41.2%, overall equipment effectiveness is increased by 28.5%, and the first pass yield of products reaches 98.6%. This paper verifies the significant positive effect of lean management on the operational efficiency of manufacturing enterprises, and provides a replicable lean implementation path for similar small and medium-sized manufacturing enterprises.

Keywords

Industrial Engineering; Lean Management; Operational Efficiency; Value Stream Mapping; Process Optimization; Auto Parts Manufacturing; Work-in-Process Inventory

1. Introduction

The manufacturing industry is the backbone of the national economy, and the auto parts manufacturing industry, as the foundation of the automobile industry, directly determines the overall competitiveness of China's automobile industry. In recent years, with the continuous rise of raw material prices, increasing labor costs and increasingly fierce market competition, small and medium-sized auto parts manufacturing enterprises in China are facing unprecedented survival pressure. How to improve operational efficiency and reduce production costs under limited

resource conditions has become the core issue that enterprises urgently need to solve.

Lean management originated from the Toyota Production System in Japan, and its core idea is to eliminate all unnecessary waste and achieve the overall optimization of the production system through continuous improvement. As an important branch of industrial engineering, lean management has been widely applied in the global manufacturing industry and has become an effective tool to improve enterprise operational efficiency. However, many small and medium-sized manufacturing enterprises in China often encounter problems such as mechanical copying, formalism and lack of systematization when implementing lean management, resulting in unsatisfactory implementation effects.

Existing studies on lean management mostly focus on theoretical discussion and application cases of large enterprises, and there are relatively few studies on specific implementation paths and effect evaluation for small and medium-sized auto parts manufacturing enterprises. Based on this, this paper takes an auto chassis parts manufacturing enterprise in Sichuan Province as the research object, constructs a lean management implementation system suitable for small and medium-sized manufacturing enterprises from the perspective of industrial engineering, and verifies its effectiveness through empirical research. The research results can provide reference and guidance for similar enterprises.

The rest of this paper is organized as follows: Section 2 reviews the relevant literature and introduces the theoretical basis of lean management; Section 3 describes the research design and the basic situation of the case enterprise; Section 4 elaborates the implementation process of lean management and process optimization; Section 5 evaluates the implementation effect from both quantitative and qualitative dimensions; Section 6 summarizes the research findings, puts forward management suggestions, and points out the research limitations and future prospects.

2. Literature Review and Theoretical Basis

2.1. Development of Lean Management Theory

The concept of lean management was first proposed by James Womack and Daniel Jones from the Massachusetts Institute of Technology in their book The Machine That Changed the World. They conducted an in-depth investigation on automobile manufacturing plants in 17 countries around the world, summarized the essence of the Toyota Production System, and named it "lean production". Since then, lean management theory has been continuously developed and improved, expanding from the initial production field to various operational links of enterprises, forming a comprehensive management system covering production, management, marketing, service and other fields.

The core of lean management is to eliminate waste, which includes seven types:

overproduction, waiting time, transportation, inventory, unnecessary processing, unnecessary motion, and product defects. Its main tools include value stream mapping, 5S management, standardized operation, quick die change, kanban pull system, total productive maintenance (TPM), continuous improvement (Kaizen), etc. These tools complement each other and jointly form the methodological system of lean management.

2.2. Research on the Relationship between Lean Management and Operational Efficiency

Domestic and foreign scholars have carried out a large number of empirical studies on the relationship between lean management and operational efficiency. Shah and Ward (2003) found through a survey of American manufacturing enterprises that lean management practices have a significant positive correlation with enterprise operational performance. Fullerton and McWatters (2001) also confirmed that the implementation of just-in-time (JIT) production, which is an important part of lean management, can significantly improve the production performance of enterprises.

Domestic scholars have also obtained similar conclusions. Zhang et al. (2019) found that lean management can significantly improve the operational efficiency of manufacturing enterprises by optimizing production processes, reducing inventory levels and improving equipment utilization. Chen et al. (2021) pointed out that for small and medium-sized manufacturing enterprises in China, lean management is an effective way to break through the development bottleneck and enhance competitiveness.

However, some scholars have noted that the implementation effect of lean management is affected by many factors such as enterprise scale, industry characteristics and management level. Small and medium-sized manufacturing enterprises face more challenges when implementing lean management due to limited resources and weak management foundation. Therefore, it is necessary to design a lean management implementation path that is suitable for their actual situation according to the characteristics of small and medium-sized manufacturing enterprises.

3. Research Design and Case Enterprise Overview

3.1. Research Method

This paper adopts the case study method, combining quantitative analysis and qualitative analysis, to study the implementation effect of lean management in auto parts manufacturing enterprises. First, identify the problems existing in the production process through on-site investigation and data collection; then, design targeted optimization schemes using lean management tools and organize their implementation; finally, compare the key performance indicators before and after implementation to evaluate the implementation effect comprehensively.

3.2. Overview of the Case Enterprise

The case enterprise selected in this paper is an auto chassis parts manufacturing enterprise located in Sichuan Province, China, which was established in 2010. It mainly produces auto shock absorbers, suspension arms and other chassis parts, and its products are mainly supplied to many domestic automobile original equipment manufacturers. The enterprise has more than 200 employees, and has four production workshops: stamping, welding, painting and final assembly, with an annual production capacity of about 500,000 sets.

In recent years, with the rapid growth of market demand, the production scale of the enterprise has been expanding continuously, but the problem of low operational efficiency has become increasingly prominent. The main problems are as follows: long production cycle, the production cycle of core products is as long as 72 hours; serious backlog of work-in-process inventory, the average work-in-process inventory is about 15 million yuan; low equipment utilization, the overall equipment effectiveness is only 52%; low first pass yield of products, about 92%. These problems have seriously restricted the development of the enterprise, leading to high production costs and declining market competitiveness.

4. Implementation of Lean Management and Process Optimization

4.1. Current Situation Analysis and Problem Identification

First, the value stream mapping tool is used to draw the current state value stream map of the enterprise's core product (shock absorber), and a comprehensive analysis is conducted on the entire production process from raw material warehousing to finished product delivery. Through analysis, it is found that there is a large amount of waste in the production process of the enterprise, mainly including:

- Overproduction: Each process produces independently according to its own plan, leading to a large backlog of work-in-process between processes;
- Waiting time: Long waiting time between processes, accounting for 65% of the total production cycle;
- Transportation waste: Unreasonable workshop layout, resulting in long material transportation distance and frequent handling;
- Motion waste: Non-standard worker operations, with a large number of unnecessary bending, turning and walking actions;
- Equipment failure: Inadequate equipment maintenance, resulting in frequent failures and long downtime.

4.2. Design of Lean Optimization Scheme

Aiming at the above problems and combined with the actual situation of the enterprise, the following lean optimization schemes are designed:

- **Implement 5S management**: Carry out sorting, rectifying, cleaning, standardizing and sustaining activities on the production site to improve the production environment and work efficiency;
- **Promote standardized operation**: Formulate detailed standard operation instructions for each process, standardize worker operations, and reduce unnecessary motion waste;
- **Optimize workshop layout**: Re-plan the workshop layout according to the product process flow, and arrange the equipment in a U-shape to shorten the material transportation distance;
- **Implement quick die change**: Transform stamping and welding equipment for quick die change, and standardize the die change process to shorten die change time;
- **Establish kanban pull system**: Replace the original push production system with a pull production system driven by the next process to reduce work-in-process inventory;
- **Promote total productive maintenance (TPM)**: Establish a preventive equipment maintenance system, and train operators to carry out daily equipment maintenance to improve equipment utilization.

4.3. Scheme Implementation Process

The implementation of lean management in the enterprise is divided into three phases, lasting for 6 months:

- **Preparation phase (Month 1-2)**: Establish a lean management promotion team led by the general manager, conduct systematic lean management training for all employees, and formulate a detailed implementation plan and assessment mechanism;
- **Pilot phase (Month 3-4)**: Select the final assembly workshop as the pilot workshop, implement 5S management, standardized operation and kanban pull system first, summarize the experience and problems in the implementation process, and adjust and optimize the scheme;
- **Comprehensive promotion phase (Month 5-6)**: Extend the successful experience of the pilot workshop to stamping, welding and painting workshops, fully implement all optimization schemes, and establish a long-term continuous improvement mechanism.The mechanism includes monthly improvement meetings, employee suggestion rewards and quarterly effect reviews.

5. Evaluation of Implementation Effect

5.1. Quantitative Effect Evaluation

By comparing the key performance indicators before and after the implementation of lean management, the implementation effect is evaluated, and the results are shown in **Table 1**.

Table 1. Comparison of key performance indicators before and after lean management implementation

Indicator	Before implementation	After implementation	Improvement rate
Production cycle (hours)	72	48.5	32.7%
Work-in-process inventory (15 million yuan)	1500	882	41.2%
Overall equipment effectiveness	52%	66.8%	28.5%
First pass yield	92%	98.6%	7.2%
Material handling distance (meters)	1200	580	51.7%

It can be seen from **Table 1** that after the implementation of lean management, all key performance indicators of the enterprise have been significantly improved. Among them, the production cycle is shortened by 32.7%, the work-in-process inventory is reduced by 41.2%, the overall equipment effectiveness is increased by 28.5%, the first pass yield of products is increased to 98.6%, and the material transportation distance is shortened by 51.7%. These data fully prove that lean management has a significant positive effect on improving the operational efficiency of manufacturing enterprises.

5.2. Qualitative Effect Evaluation

In addition to the above quantitative effects, the implementation of lean management has also brought significant qualitative effects:

- Improvement of employee quality: Through systematic lean management training and practical participation, employees' lean awareness and operational skills have been significantly improved, and their sense of responsibility and initiative have been enhanced;
- Improvement of management level: A standardized and refined management system has been established, making enterprise management more scientific and efficient;
- Construction of corporate culture: A corporate culture of "continuous improvement and pursuit of excellence" has been gradually formed, and the cohesion and centripetal force of the enterprise have been enhanced;
- Enhancement of market competitiveness: Production costs have been reduced, product quality has been improved, and the enterprise's ability to respond to market demand has been enhanced, thus improving its market competitiveness.

5.3. Existing Problems and Improvement Directions

In the process of implementing lean management, some problems have also been found: First, some employees, especially older employees, have insufficient understanding of lean management and low participation enthusiasm; Second, the lean management system is not perfect enough, and the continuous improvement mechanism needs to be further strengthened; Third, the coordination degree with upstream and downstream enterprises in the supply chain is not high, which affects

the overall effect of lean management.

Aiming at these problems, the future improvement directions are as follows: Strengthen targeted training for employees to improve their lean awareness and participation; Improve the lean management system and establish a more effective continuous improvement incentive mechanism; Strengthen cooperation with upstream and downstream enterprises in the supply chain to promote the overall lean of the supply chain.

6. Conclusions and Suggestions

6.1. Research Conclusions

This paper takes an auto chassis parts manufacturing enterprise in Sichuan Province as the research object, and applies lean management tools such as value stream mapping, 5S management and standardized operation to carry out systematic process optimization from the perspective of industrial engineering. The research results show that lean management can significantly improve the operational efficiency of manufacturing enterprises, which is specifically manifested in shortened production cycle, reduced work-in-process inventory, improved overall equipment effectiveness and improved product quality. The lean management implementation system constructed in this paper has strong practicability and operability, and can provide reference for similar small and medium-sized manufacturing enterprises to implement lean management.

6.2. Management Suggestions

- **Senior leaders should attach great importance and personally promote**: Lean management is a systematic project that involves all aspects of enterprise operation, and requires the strong support and personal promotion of senior leaders to ensure the smooth implementation;
- **Strengthen employee training and participation**: Improve the lean awareness and operational skills of all employees through training, and encourage employees to actively participate in lean improvement activities to make them the main force of lean management;
- **Proceed step by step and adhere to continuous improvement**: Lean management is not a one-time project, but a long-term process. Enterprises should proceed step by step according to their own actual situation, and continuously find and solve problems to achieve sustainable improvement;
- **Combine with the actual situation of the enterprise**: Do not copy the experience of other enterprises mechanically, but formulate a lean management implementation plan that is suitable for the characteristics and development stage of the enterprise.

6.3. Research Limitations and Future Prospects

The limitation of this paper is that only one auto parts manufacturing enterprise is

selected as the research object, and the universality of the research results needs to be further verified. Future research can expand the sample range, conduct comparative studies on manufacturing enterprises in different industries and different scales, and further explore the influencing factors and mechanism of lean management implementation effect, so as to improve the lean management theory and method system.

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