

# Research on the Development of Lean Production Digitization in Modern Enterprises

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## Abstract

Lean production is a type of production management that aims to eliminate unnecessary waste, making it possible to reduce costs while maximizing productivity and quality. However, with the development of the times, the traditional lean production model has been gradually replaced by digital lean production. This article reviews the relevant research on digitization and lean production, points out some existing problems, and puts forward relevant feasible suggestions.

## Keywords

Digitization; Lean Production; Enterprise.

## 1. Introduction

With the continuous advancement of economic globalization and science and technology, mankind has gradually entered the digital age. The increasingly competitive market environment has put forward higher requirements on the production management model of enterprises. Lean production is a production management method evolved from Toyota Production System (TPS) [1]. Its purpose is to improve the production process by reducing waste and improving efficiency, thereby improving product quality, reducing costs and increasing production efficiency. As a higher stage of production management, lean production can fully consider the real needs of target customers, reduce enterprise costs and continuously improve production plans in the production and operation process of enterprises. It enables enterprises to bring more efficient operation efficiency with less capital investment, shorten product production cycle and improve the ability of companies to adapt to the market [2]. Lean production is particularly important for the development of modern enterprises. In recent years, lean production management model has gradually been adopted by more and more enterprises. This trend is aimed at improving the competitiveness and profitability of enterprises, better meeting the needs of consumers in the market, and thus promoting the sustainable development of enterprises.

However, digitization has become an integral part of modern society. Digital technologies have made it possible to collect and process large amounts of data in the process of production and management. At the same time, digital technologies can also accelerate the flow of information, thus improving production efficiency and production quality. As more and more enterprises begin to introduce digital technologies, lean production also needs to be adapted and updated to meet changing market demands and technological developments. With the wide application of digital technologies such as big data, cloud computing, artificial intelligence, and the Internet, the connection between lean production and digitization will become increasingly close. Through the application of digital technology, the production of enterprises can be more intelligent and efficient, so that the concept of lean production can be better implemented into production practice. Therefore, it is particularly important to study the development of lean

production in the context of digitization. Further research is needed to explore how to integrate digitization with lean production in order to achieve cost reduction, quality improvement, and sustainable development.

## 2. Literature Review

### 2.1. Lean Production

Lean production was first proposed by Womack et al. (1990) [3] in "The Machine That Changed the World." It is based on the TPS and consists of "one goal, two pillars, and one foundation" [4]. Many scholars believe that lean production evolved from the TPS, which can be seen as an affirmation of it, so there is no essential difference between the two. However, lean production is actually a management mindset that has been digested, upgraded and transformed, and has gone beyond the scope represented by TPS [5].

Lean production is a customer-oriented and market-oriented way of production. It emphasizes improving production efficiency and product quality by eliminating all kinds of intangible and tangible waste, achieving optimization at each stage, and thus enhancing the competitive advantage of products [6]. In addition, just-in-time (JIT) and automation are two pillars of lean production. JIT emphasizes accurate planning and coordination at every step within the production line to minimize wait times and material inventory. Automation means making the operations in the production process as autonomous as possible to increase efficiency and accuracy and reduce human errors. However, the foundation and core of lean production remains continuous improvement. In lean production, improvement is a continuous process. Through continuous improvement, lean production can continuously optimize the production process, improve product quality and customer satisfaction, and ultimately realize sustainable development of enterprise [7]. The essence of lean production is an operational culture that can be approached from all aspects of production and management. It minimizes the production costs of an enterprise and maximizes its operational efficiency on the basis of ensuring product quality. The aim is to achieve the goal of optimal product quality and thus gain an advantage in the fierce market competition. Compared with other management models, lean production has the ability to adjust to market demand. It is closer to the production practice, can effectively reduce the potential risks in production, maximize the satisfaction of customer demand, make the enterprise management more scientific and standardized, and then improve its management effect [8], [9].

An & Pan (2015) argue lean production has a significant positive impact on enterprise development[10]. It promotes management innovation by improving the enterprise management level, thus improving their competitiveness and market position [4]. Han (2022) believes that lean production can reduce raw material, labor and manufacturing costs, eliminate redundancy and unnecessary waste, and improve the utilization of enterprise resources[11], thus achieving the goal of reducing costs and improving efficiency [12]. Liu (2022) argues that lean production can also achieve low-carbon manufacturing, reduce pollution on the environment, in line with the concept of sustainable development[13]. Finally, lean production also improves employee unity and creativity, creating an efficient and collaborative corporate culture, which further promotes the growth of the organization [14].

### 2.2. Digitization and Lean Production

Although lean production can create a lot of value for enterprises, its original theoretical defects limit the effective utilization of its actual value [15]. Wickens (2007) states that traditional lean production is overly concerned with eliminating waste, lacks motivation and initiative in the value creation process, and ignores the entrepreneurial spirit to optimize the value creation process [16]. Lean concepts and production activities are mostly confined to inventory control

and production resource planning, and lack broad integration into multi-value collaborative activities [17]. Pei & Wang (2016) argues that traditional lean production emphasizes customer satisfaction in isolation as the key to long-term success, while ignoring the important role of other stakeholders in achieving production value objectives [18]. Firms need to be more flexible in responding to market changes, distinguishing between stakeholders and customers, and taking into account the needs and interests of all parties involved in order to facilitate competitiveness and value creation. With the advent of the digital age, traditional lean manufacturing has struggled to quickly coordinate change in response to unforeseen circumstances. Therefore, lean production theories need to be further developed in order to better cope with the changing market environment.

Digitization is considered as a tool to improve lean production efficiency, which can help enterprises to coordinate changes quickly and improve productivity. Digitization can combine lean production with other strategic resources to better respond to change and create value, thereby increasing the competitiveness and productivity of enterprises. Although there is a lack of systematic discussion in academia about digital lean production, research has begun to realize the positive impact of digitization on lean production.

Chen et al. (2020) believe that digital technology has demonstrated strong lean efficiency in the production and operation of enterprises [19], providing important conditions for building digital advantages in lean production. The application of digital technology in various areas, such as the Internet of Things (IoT), cloud computing, and data analytics, provides a broader space for enterprise intelligence and digitization. This enables companies to operate more efficiently, reduce waste, optimize production processes, and improve quality and customer satisfaction. Enterprises can actively take advantage of digital opportunities, cultivate and develop digital skills, and effectively combine and apply them with existing lean production practices to build strong lean production capabilities and effectively improve enterprise productivity [20].

Digital technology plays an important role in demand forecasting. With the widespread use of digital technology, companies are able to gain a more comprehensive understanding of markets and customers and respond effectively to rapid changes in the marketplace. In particular, by mining and analyzing customer feedback and comment data, companies can not only quickly understand consumer needs and preferences, but also quickly adjust production plans to meet these needs, shifting from passively following market changes to actively creating and exploring market demand [19], [21].

Digital technology also enables real-time monitoring of potential operational risks. It promotes automatic and reasonable scheduling of resources through data interaction, monitors the production process in real time through various devices and sensors, handles problems in time, and improves production efficiency. It also provides new ideas to improve production level through statistical analysis of production data, identify and eliminate waste, and reduce production cost [22][23], [24].

In addition, Fang et al. (2019) believe that digitization runs through the entire production and operation process [25]. Through automation and robotics technologies, it realizes automatic control of production processes, improves capacity utilization and reduces production costs, and further improves production efficiency. Digital technology plays a crucial role in supply chain management. By realizing high symmetry of information, digital technology can better screen and match cooperation resources outside the scope of time and space, and improve the management level of supply chain [19][26]. This not only effectively reduces the operating costs, but also improves supply chain efficiency, speeds up production cycles and brings higher production efficiency.

Digital technology plays important roles in organizational change. Digital technology enables real-time measurement and tracking of employee performance by digitizing and modeling tasks and resources, which improves productivity and makes organizational workflows more efficient and faster. The openness and transparency of digital technology can effectively strengthen communication and cooperation among different departments, break the traditional top-down linear workflow, help improve the effectiveness of cross-departmental cooperation and the fineness of work execution, and ensure the smooth realization of organizational change tasks. With the support of digital technology, organizations can conduct internal collaboration and resource allocation more efficiently, and quickly adapt to market demands and changes [19], [26], [27].

### 3. Existing Problems

Despite the fact that digital lean production has a lot of influence on enterprise development and has achieved certain results in practice, it still has some problems.

**Difficulty of scaling.** As companies transition from small-scale digitization to large-scale digitization, they will face more technical and system challenges and need to consider more factors, such as network architecture, software integration, and data analytics, which increase the difficulty of digitization and scaling. Large-scale factories and supply chain systems require more technology and systems than small-scale production lines. This requires companies to invest more resources and time in developing a comprehensive digital transformation plan that takes into account network and system architecture, data analytics, security and stability in order to improve the efficiency and productivity and thus maintain a competitive edge.

**Availability of data.** As digital transformation expands, large amounts of data will be introduced into business operations and decision-making. Managing this data can become a complex task that requires more efficient methods of data management and analysis, but many companies don't have enough data available to implement this approach. In addition, accurate and timely data remains a bottleneck. Many organizations continue to expand their data sources to fill their analytics tools, models, and insights. However, simply acquiring more data does not meet the growth needs of enterprises. Organizations need to focus on acquiring high-quality data that can be used for more granular and deeper analysis.

**Risk of privacy breaches.** Lean digitization may expose organizations to additional security and compliance challenges. As businesses become more digitized, they need to handle more and more sensitive data and information, which increases the risk of data breaches and cybersecurity threats. Cyber-attacks and data leakage in the process of digitization require companies to invest more resources and energy in prevention and response. Issues such as protecting data privacy, ensuring user security, and complying with relevant rules, laws, and regulations must be emphasized and carefully addressed.

**Complexity of technology.** Implementing lean digitization requires the use of a variety of new technologies, such as IOT, big data analytics, and artificial intelligence. These technologies may be new to many employees and require significant time and money to train. In addition, digital technology is updated very quickly, and companies need to constantly update their equipment and software to keep up with market competition, which will further increase the investment cost.

### 4. Management Recommendations

Under the background of digitization, the path of combining digitization with lean production needs to be further explored. In order to scientifically and reasonably apply digital technology

to meet the needs of different aspects of production management, while avoiding the adverse effects of digital technology applications, enterprises can take the following measures.

Transform employee perceptions and foster digital literacy. Develop clear plans and goals to help employees understand why lean digital transformation is necessary and how lean digital transformation will impact the business and future of the organization. Organizations need to focus on communicating these messages to employees so that they better understand and actively participate in the digital transformation process. To ensure that employees are competent for their jobs in digital transformation, organizations need to provide comprehensive digital training and education to improve employee digital literacy and skills, and build a digital culture to promote employee innovation awareness, thereby enhancing the digital capabilities and competitiveness of the organization.

Pay attention to environmental trends and make continuous changes. Changes in markets and consumer demands bring opportunities and challenges. Emerging technologies and production methods place companies in a constantly changing environment in which to compete. Therefore, enterprises must continue to learn and explore, and timely adjust production management strategies and programs to meet market and customer demand. Differences in different industries, products, and customer needs require enterprises to develop their production models and continuously optimize and improve production management to maintain competitiveness and sustainable development. In short, enterprises must pay close attention to the market, customer and environmental trends, continuous learning and application of new technologies, and adapt to the ever-changing external environment.

Strengthen privacy protection and ensure information security. Protecting data privacy and information security is an important issue that needs to be addressed in digital transformation. Enterprises need to strengthen cybersecurity protection and establish a sound data backup and recovery mechanism to cope with emergencies and data loss. In addition, safeguarding user security is an aspect that needs to be emphasized in the development of digital lean production. Organizations need to ensure the security and privacy protection of user data to avoid leakage or misuse of user information. Enterprises need to establish strict guidelines for the protection of user data privacy, including user data collection and use specifications, as well as user data protection and management measures to ensure the information security of enterprises and users.

Introduce digital technology and reap development advantages. As digital technology continues to evolve, companies need to adopt digital tools to keep up with the pace of digitization in order to support the digital transformation of lean production and help them realize the digitization of production processes. Through the application of digital technology, enterprises can better grasp the key data and information in the production process, accelerate the improvement of production efficiency, and at the same time improve production quality and save production costs. There is a wide variety of digital technologies, and organizations also need to choose the right digital technologies and tools based on their needs and realities. They should carefully analyze bottlenecks in their production processes and processes, as well as consider the cost and feasibility of digital technologies to ensure that they are fully utilized and generate adequate returns.

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