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Tin-Chih Toly Chen · Yi-Chi Wang

Artificial Intelligence and Lean Manufacturing

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Contents

Chapter 1
Basics in Lean Management

1.1 Introduction

Lean manufacturing, or **lean sigma**, originated in Japan and is a well-known tool for improving the competitiveness of manufacturers around the world. Lean manufacturing improves the planning, control, and management of a manufacturing system by using simple and effective tools such as kanbans, pacemaker, value stream mapping, 5s, just-in-time (JIT), standard operating procedures, load leveling, pull manufacturing, and others, as illustrated in Fig. 1.1. Common features of these tools are transparency, ease of understanding and communication, and ease of use. However, the philosophy of low volume and high diversity and pull production in lean manufacturing may not be suitable for all types of factories. Nonetheless, some lean management concepts and techniques are of reference value for all factories.

Toyota production system (TPS) is considered as the predecessor of lean manufacturing. TPS has been successfully applied to factories and supply chains around the world to shorten cycle times, regulate outputs, facilitate decision-making processes, reduce costs, and enhance worker safety [1, 2].

So far, the concepts and techniques of lean manufacturing have been applied to non-manufacturing fields, forming the concept of so-called "lean thinking", which aims to "do more with less" [3].

According to Sanders et al. [4], there are four success factors for lean manufacturing:

- Supplier relationship;
- Process and control;
- Human factors;
- Customer focus.

In the view of Melo et al. [5], human factors and ergonomics are also key considerations when planning a lean work environment. In fact, lean manufacturing environments are more likely to ensure worker health and safety.

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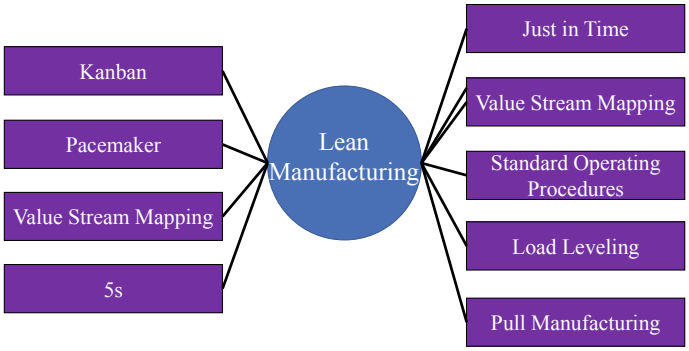

Fig. 1.1 Lean manufacturing technologies

1.2 Basic Concepts of Lean Manufacturing

1.2.1 3M and Seven Wastes

Lean manufacturing aims to eliminate three types of deviations [2, 6] that are illustrated in Fig. 1.2:

- **Muda**: Mudd includes activities that do not add value. The results of such activities are usually waste, i.e., the so-called seven types of wastes—overproduction, waiting, transportation, over processing, inventory, unnecessary motions, and product defects.
- **Mura**: Mura indicates the variability, inconsistency, unevenness, non-uniformity, or irregularity in production (in time, quantity, or quality). The existence of Mura leads to the **seven wastes**.
- **Muri**: Muri refers to situations in which operators or machines operate above their limits. Overburden, excessiveness, and unreasonableness are some synonyms of Muri. Muri may result from Mura or the excessive removal of Muda.

Therefore, activities are value-added if they avoid wastes and produce exactly what is needed, where and when it is needed.

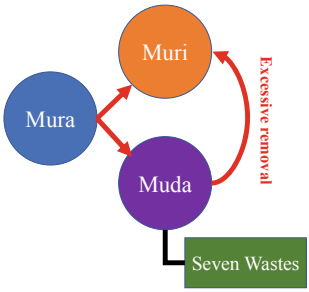

Fig. 1.2 3M and seven wastes

The elimination of 3M usually starts with eliminating Muda (i.e., seven wastes). Managers should immediately address overproduction and unnecessary waiting, shipping, handling, inventory, actions, or corrections. In fact, after the elimination of Muda, Mura, and Muri also decrease, which improves the working environment and also the working performance [5].

1.2.2 5S

5S include a series of shop floor improvement activities aimed at making the shop floor cleaner, tidier, more hygienic, and safer. Such activities are divided into five categories: Seiri, Seiton, Seiso, Seiketsu, and Shitsuke [7], as defined in Table 1.1. To the Japanese, 5S are actually a daily practice of life wisdom, so they are easy to be integrated into management practices [8]. 5S achieve cost-effectiveness by maximizing efficiency and effectiveness. In lean manufacturing, 5S are among the most prevalent and easily effective improvement activities. However, in many organizations, only the first three S activities were performed, which limited the possible benefits [9].

The rapid advancement of computer and information technologies has diversified the implementation of 5S activities. According to the findings of Gapp et al. [10], an organization website is a suitable channel for disseminating information about 5S practices. Whether **artificial intelligence (AI)**, as the most advanced computer and computing technology, can be applied to 5S activities is a topic of concern [11]. This is also a direction this book intends to explore.

1.2.3 Toyota Production System (TPS)

Toyota Production System (TPS) is the redesign of a mass production system [12]. It is a production method created and developed by Toyota by completely eliminating wastes to achieve good product quality, low costs, and short lead time (i.e., the time between a customer placing an order and the delivery of the order) [12]. It is a

Table 1.1 Definitions of 5S

Kaizen activity	Definition
Seiri	Throw away useless stuff
Seiton	Align, sort materials, workpieces, tools, finished goods, etc
Seiso	Clean the shop floor
Seiketsu	Keep the cleanliness of the shop floor
Shitsuke	Educate people to get used to the continuous implementation of 5S activities