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# A Manufacturing Strategy: An Overview of Related Concepts, Principles and Techniques

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**Abstract:** The purpose of this study is to define and discuss the related concepts, tools and techniques of lean production system- a widely used manufacturing strategy. This paper basically introduces the most basic lean tools and techniques necessary to understand this management philosophy and reap its full benefits. Since the term associated with lean practice pose problems of definition and concept, it is therefore deemed necessary to outline the basic elements connected with the lean production. This study is an overview of the conceptual framework of lean. A desk study was conducted to gather relevant information in this regard.

**Key words:** Lean, manufacturing strateg, principles

## INTRODUCTION

The objective of this study is to outline the related concepts of lean production philosophy. For this purpose an extensive literature review has been conducted. It is said that Japan was the birthplace of lean production (Sohal and Egglestone, 1994). The changes in the economic and competitive climate in Japan led the manufacturing organizations to devise innovative and cost-effective production methods. And, this encouraged the organizations to look for a revision of the production models as well as the Japanese management system (Bartezzaghi, 1999). While the overall Japanese economy has suffered, some well organized Japanese manufacturing companies such as Toyota, Honda, and Canon still remain competitive in the global market (Phan and Matsui, n.d.). This is because of the Japanese own way of management such as JIT production, TQM and concurrent engineering (Morita *et al.*, 2001). These are considered as the main strengths of the Japanese manufacturers, besides their technological advantages (Sakakibara *et al.*, 1993; Morita *et al.*, 2001; Matsui and Sato, 2002). After World War II when Japanese manufacturers realized that they could not afford the expense to build facilities like the USA, they concentrated on lean concept (Pavnaskar *et al.*, 2003). They began the process of developing and refining the process of manufacturing with a view to minimize waste (Thompson and Mintz, 1999).

Different factories of Japan have started to use this system after it has been implemented in Toyota. After Japan, the US firms became interested to this concept followed by the European countries. But now the Asian countries as well as other countries of the world are also using this technique to meet their customer requirement (Mazany, 1995; Bruce *et al.*, 2004).

The last two decades have seen the top Japanese manufacturing firms have achieved excellent international competitiveness in a number of industries such as auto, electronics and machinery (Wu, 2003). They have achieved success due to their different ways of doing business. Hall (1983) and Schonberger (1982) argued that the Japanese developed a new approach to manufacturing management. The book by Womack *et al.* (1990), 'The Machine That Changed the World' benchmarked manufacturing companies around the world and found, at the time, the Japanese manufacturers were typically more productive and efficient than their Western counter parts. Taichii Ohno in his book oyota Production System explained the foundations of lean manufacturing and showed that these principles guided the Japanese companies to be world class (Ohno, 1988). Literature revealed that Japanese firms are superior in performance compared to the European firms because of the introduction of lean in manufacturing sectors (Sohal, 1996). Due to the differences in the strategies and practices, Japanese firms were highly focused on lean practices and followed integrated single piece production flow, low inventories, small lot sizes, defect prevention rather than rectification, pull production, team-based work and active involvement in problem solving to eliminate all non-value added wastes. These practices helped them become superior in performance compared to other countries. Manufacturing priorities in Japan are quite different from that of the USA and European manufacturers. As stated by Sohal (1996), the main goals of Japanese manufacturers are improving quality, reducing costs, and product development. Oliver *et al.*

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(1993) in their study of 18 auto component plants (nine UK firms and nine Japanese firms) reported that five plants displayed high performance on measures of productivity and quality. All of them are located in Japan. These companies showed consistently superior performance on a number of measures, and thus provided support for their lean production system. As stated by Morita *et al.* (2001), Japanese could still be competitive because they have not yet lost their competitiveness.

Lean production encompasses the total manufacturing chain from product design to product development, and it even embraces distribution (Cooney, 2002). According to the National Institute of Standards and Technology Manufacturing Extension Partnerships Lean Network, lean refers to systematically identifying and eliminating waste through continuous improvement using the pull production with a view to get perfection (Kilpatrick, 2003). Lean shortens the lead-time between a customer order and the shipment of the products by elimination of all forms of waste in the production processes. Simply said, ean principles and methods focus on creating a continual improvement of culture that engages employees in reducing the intensity of time, materials and capital necessary for meeting customer need (EPA, 2003). This operational strategy targets to achieve the shortest possible cycle time by eliminating waste. This strategy aims to increase the value-added work by reducing incidental work. This technique is used to increase profitability by reducing cost and by understanding the meaning of value to the customer because value is the major determinants of lean manufacturing. Companies are now convinced about the benefits of lean, and they are using this technique in both production and service functions.

Ss stated by Katayama and Bannett (1996), it is the paradigm for operations and its influence can be found in a wide range of manufacturing and service strategies (Womack and Jones, 1994). The benefits of lean manufacturing are evident in factories across the world and companies report improved product quality, reductions in cycle time, reduced work-in-progress (WIP), improved on-time deliveries, improved net income, decreased costs, improved utilization of labor, reduction in inventories, quicker return on inventory investment, higher levels of production, improved flexibility, improved space utilization, reduction in tool investment, a better utilization of machinery, stronger job focus, and better skills enhancement (Pavnaskar *et al.*, 2003).

Lean Production is a conceptual framework based on a few established principles and techniques (Sanchez and Perez, 2001) as depicted in Fig. 1. The Figure shows that several factors contribute towards achieving production and delivery just-in-time. These factors elimination of zero value activities, multifunctional teams, continuous improvement efforts, and supplier integration have influence on just-in-time production and delivery to customers. All this in an integrated manner leads companies to achieving competitiveness.

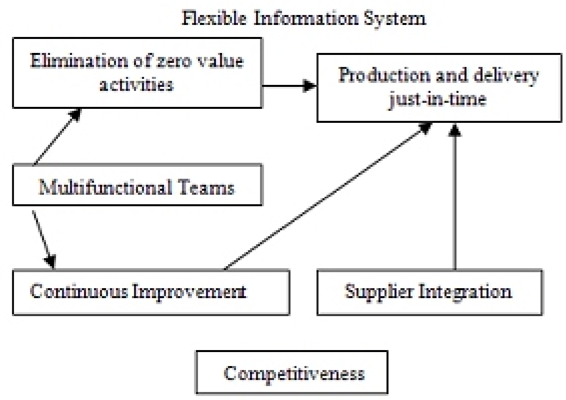


Fig. 1: A Lean Production Model Adopted from Sanchez and Perez (2001)

Table 1: Core concepts of lean

| Concepts | Details |
|---|---|
| • Value specification in the eyes of the customer | Need to specify what creates value from customer's point of view |
| • Identifying the value stream and eliminating waste | Need to identify all the activities (value stream) necessary to produce a product and eliminate all non-value added waste. |
| • Making the flow of the value at the pull of the customer | Make those actions that create value flow without interruptions at the pull of the customer. |
| • Empowering and involving the employees | Need to empower and involve the employees at the decision making. |
| • Continuously improving for getting perfection | Need to focus on continuous improvement for the perfection |

Source: Womack *et al.* (1990)

As stated earlier, Lean Production (LP) focuses mainly on ne piece flow continuous flow. This means that the ideal batch size is always one unlike in the traditional manufacturing environment where ideal batch size is determined on the basis of individual manufacturing processes or material handling. One-piece flow requires work cells that are organized by product, rather than process (Mercado, 2007). his shift requires highly controlled processes operated in a well maintained, ordered and clean operational setting that incorporates principles of Just-in-time production and employee involved, system wide, continual improvement (EPA, 2003). Precisely, LP itself encompasses, as identified by Womack and Jones (1994), five core concepts, as presented in Table 1.

## RESULTS AND DISCUSSION

**Concept, tools and techniques of lean production:**
**Concept of inventory:** As stated by Womack *et al.*

(1996), the aim of lean production is to eliminate everything that does not add value to the product or service. Inventories are symptoms of inefficiency, because it does not add value to the products (Sanchez and Perez, 2001). urthermore, inventories also hide other problems on many occasions, preventing their solution like, for example, a defective maintenance that focuses the accumulation of stocks to prevent bottlenecks in the machines which break down frequently (Sanchez and Perez, 2001). Lean manufacturing focuses on fewer inventories of raw materials and finished goods kept in storage. Organizations maintain inventories of raw materials; work in process and finished goods to maintain flexibility in their production processes, smooth out periods of excess or under capacity. In a lean production system, inventory is considered as a waste. This concept implies that excess of inventory incurs more cost, which ultimately increases the cost of customer product.

**Concept of JIT:** Since the early 1980s, Just-in-Time production has received great interest internationally (Phan and Matsui, n.d.). In general, the JIT philosophy concentrates more on improving manufacturing efficiency by eliminating non-value added activities and minimizing inventory (Lau, 2000). Just-in-Time (JIT) practices have been used by many manufacturers as a powerful tool for continuous manufacturing improvement based on the significant reduction of inventory and work-in-progress in all phases of manufacturing process. This philosophy emphasizes materials flow not on materials storage (Kamoun and Yano, 1996). Originally JIT manufacturing concentrated more on increasing manufacturing efficiency by eliminating all forms of waste and minimize inventory (Lau, 2000). Today more and more North American firms and firms in many other countries use it as an approach to produce the right part in the right place at the right time. Traditionally, inventory has been viewed as an asset. But the JIT view is that inventory does not add value but instead incurs costs. JIT views inventory as a symptom of inadequate management, a method of hiding inefficiencies and problems (Sanchez and Perez, 2001). As stated by Schroeder and Flynn (2001), JIT system reduces inventory, lowers cost and improves quality. According to Hines (1996), many companies use JIT delivery as a key element in lean production development. Ultimately, IT enables a company to produce the products its customer want, when they want them, in the amount they want (EPA, 2003).

**Concept of *Kanban*:** Lean production greatly emphasizes *Kanban* system use of physical inventory cues to signal the need to move raw materials or produce new components from the previous process (EPA, 2006). Same report stated that a kanban is a card, labeled container, computer order or other device used to signal that more products or parts or other materials are needed from the previous process. Anecdotal evidence indicates that through this system, components are delivered to the production line when needed, so that there is no storage in the production area. This is a system of delivery instructions from downstream to upstream activities in which the upstream suppliers do not produce until the downstream customer signals a need (Alukal and Manos, 2002). As stated by Phan and Matsui (n.d), the Kanban is a physical tool for operating the pull system and this system helps the factory in the reduction of unnecessary production, minimizing the work-in-process inventory.

**Concept of continuous improvement/Kaizen:** Lean production is founded on the idea of Kaizen or continual improvement (EPA, 2003). Continuous improvement is an ongoing program of improving quality, costs, and lead-time of processes and products through the cooperative efforts of all concerned. According to Oakland (1993), the search for continuous improvement in the products and processes is another feature of lean production. As defined by Sanchez and Perez (2001), ontinuous improvement is a process that requires involvement of employees at different levels and support of management. This process relates to the idoka concept, which states that since people are not working for the machine, they have the ability to use their best judgment to improve the process. This concept is often referred to as Kaizen, which is used by the Japanese. his philosophy implies that small, incremental changes routinely applied and sustained over a long period results in significant improvements (EPA, 2003). Kaizen is considered as the uilding block of all lean production method. In his book, Imai (1986) emphasized that the key to Japan competitive success in the face of fierce global competition is the adoption of aizen in the firms. He focused on the kaizen management practices that can be put to work for improvement of processes. According to him, kaizen is a vital approach to problem solving, however, its application requires change in the corporate culture.

**Waste:** The elimination of waste is the prime focus in lean production processes. Lean production basically focuses on elimination of several types of waste. By avoiding non-value added activity, lean tries to increase the customer responsiveness. n its most basic form, lean manufacturing is the systematic elimination of waste from all aspects of an organizations, operations, where waste is viewed as any use or loss of resources that does not add directly to creating the product or service a customer wants, when they want it (EPA, 2003). One study (Suzaki, 2000), defined waste as anything beyond the minimum needed by an organization in terms of equipment, materials, components, space or worker time to give added value to the products. That means, anything that

Table 2: Seven wastes of lean

| Types of waste | Details |
|---|---|
| Over-production | Producing too many products than the required. This creates excess of inventory, which ultimately leads to high product cost. |
| Excessive transportation | Transporting or moving products from one place to another than the required. Excessive movement causes both quality and revenue issues because this creates additional organizational cost. |
| Waiting time waste | Long periods of inactivity for people, information or goods, resulting in poor flow and long lead times |
| Excessive inventory | Having excess of inventory or more inventory than is minimally required, results in inventory waste |
| Unnecessary motion | When people involved in the production process move / walk unnecessarily, that does not add any value to the end product. This is called motion waste. |
| Inappropriate processing | Using the wrong set of tools, procedures or systems in the work processes. |
| Waste in defects | Production of defective units involves inspection and fixation of the defective items. Defects that force reworks, or products to be scrapped, exact a tremendous cost on the organizations through the infrastructure changes needed to quarantine the defects, re-inspect the reworked material, and re-scheduling the reworked material back into the production line. |

Source: Shingo (1992)

increases cost without adding value to the product is a waste. Shingo (1992) strongly emphasized the elimination of waste. He advised the managers not to accept any waste as unavoidable. Nicolas (1998) and Boeing Company, (2000) identified several types of waste such as waste of complexity, labor, space, overproduction, time, transport, energy, defect and materials. Shingo (1992) identified seven different types of wastes as illustrated in Table 2.

Table 2 presented the most basic forms of wastes involved in the production process. Lean philosophy shortens the lead-time, reduces the manufacturing cycle time and improves the manufacturing performance by eliminating these wastes from the production processes.

**Core characteristics of lean production practice:** Lean production has several characteristics as identified in researches. Oliver *et al.* (1993) identified seven core characteristics of lean production:

- Organization with team that involves flexible, multi-skilled operators taking a high degree of responsibility for work with their areas.
- Shop-floor with problem solving structure which is central to kaizen or continuous improvement activities.
- Lean manufacturing operations: low inventories, small number of direct workers, small batch size, just in time production.

Table 3: Building blocks of lean

| Building blocks | Descriptions |
|---|---|
| 5S | 5S is considered as an important building block of lean. Its underlying philosophy is that efficient and quality work requires a clean and safe environment. The 5S activities refer to five Japanese terms such as (i) *Seri* (sorting out unnecessary items in the workplace and discard them), *Seiton* (arranging all necessary items in good order so that they can be easily picked for use), *Seiso* (cleaning the workplace completely so that there is no dust on the floor, machines or equipment), *Seiketsu* (maintaining a high standard of housekeeping and workplace at all times), and *Shitsuki* (training people to follow good housekeeping disciplines autonomously). Briefly, this is a system for organizing the workplace and housekeeping which is carried out gradually and systematically. The goal of this technique is to create a working environment that is organized, simple, clean and safe. |
| Visual control | Lean requires the placement of all tools, parts and production activities in such a manner so that everyone involved in the process can easily view and understand the whole system at a glance. This visual control helps people see what is happening in each stage and what can be required. |
| Streamlined layout | This focuses on designing the plant layout sequentially. The layout design should follow the optimum operational sequence. |
| Standardized work | Lean requires consistency in the performance of task. This building block emphasizes on standard task performance but with prescribed methods and without any waste. |
| Teams | Lean highly emphasizes teamwork. Teams can perform more effectively than the individual. In this system teams can be an improvement team or daily work-team. |
| Quality at the source | Lean requires quality at the very beginning. Operators will inspect and use process control, so that they become sure that the product that is passed on to the next process is of acceptable quality. |
| Point of use storage | Raw materials, parts, information, tooling, work standards, procedures etc. are stored where needed. |
| Quick changeover | The ability to change tooling and fixtures rapidly (usually in minutes) so that multiple products in smaller batches can be run on to the same equipment. |
| Pull /Kanban | A system of cascading production and delivery instructions from downstream to upstream activities in which the upstream supplier does not produce until the downstream customer signals a need. |
| Cellular /Flow | Physically linking and arranging manual and machine process steps into the most efficient combination to maximize value added content while minimizing waste. The aim is single piece flow. |
| Total Productive Maintenance | A lean equipment maintenance strategy for maximizing overall equipment effectiveness. TPM empowers workers to maintain and improve operations and equipment in their work areas, preventing breakdowns, malfunctions and accidents. |

Source: Alukal and Manos (2002)

- High commitment human resource policies, which encourage a sense of shared destiny within a factory.
- Close relationship with suppliers and smaller supplier base.
- Cross-functional development teams.
- Retailing and distribution channels which provide close links to the customer and permit a make to order strategy to operate.

Presence of these characteristics in a production system makes the system lean. It suggests that lean production system, in order to be really useful in eliminating wastes, requires team organization structure with cross-functional development teams, problem-solving structure in the shop floor, small quantity of inventories, small batch size, just-in-time production and delivery, flexible and employee-oriented human resource policies, integration with a small base of suppliers, and close links to the customers. Thus, lean encompasses the entire enterprise: from the shop floor to the executive suit and from the supplier to customer value chain.

**The building blocks of lean:** Lean is established upon several building blocks. Alukal and Manos (2002) have identified the building blocks presented in Table 3. These include 5S, visual control, streamlined layout, standardized layout, teams, quality at source, point of use storage, quick changeover, pull/kanban, cellular/flow, and Total Productive Maintenance (TPM). These building blocks need to be in place in an organization in order to be successful with the lean production system.

All these building blocks are keys to lean production. In order to be truly lean, working environment needs to be organized, clean and safe. These are necessary ingredients for an efficient and quality work. When employees can have a clear view of what is happening, they can understand easily the whole system that results in higher productivity. Operationally sequential plant layout helps in reducing cycle time. Standardized work facilitates consistency in the performance of employees. Well-organized work-teams perform better in achieving higher productivity with less input and efforts. Ensuring quality from the very beginning of the production process reduces the chance of having unexpected scrap/defects in the subsequent stages of production. Storing necessary materials and other things close to the place of work/use improves production efficiency. Kanban reduces the inventory level through using systematic and timely signaling for 45 materials. As a building block of lean, TPM focuses on overall equipment effectiveness through regular, routine maintenance of equipments.

## CONCLUSION

The lean production system is important for improving a firm competitiveness. Lean practice, however, requires establishment of several building blocks as well as consideration of a number of conceptual issues such as value specification, value stream, waste elimination, empowerment of employees and continuous improvement. All these together create the foundation for lean implementation.

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