

## Lean Thinking: An Overview

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### Abstract

The lean manufacturing is a popular means of continuous improvement that has reshaped manufacturing processes, practices, and principles globally. Originating from the automobile industry, the approach has been used extensively in the manufacturing sector since the 1990s. Basically, lean manufacturing centered around the philosophy of continuously improving performances by systematically eliminating wastes in the manufacturing floor. Lean thinking was introduced to extend the concept from the manufacturing floor to a business operation level. This paper is intended to provide an overview on the concept of lean thinking, discuss in details the five key principles constituting the concept.

**Keywords:** Lean thinking; Lean manufacturing

### Introduction

One of the most commonly talked about manufacturing approach in the sector for almost past three decades is the lean approach despite the disputation on the approach uniqueness in comparison with other alternate manufacturing approaches. According to Herzog and Tonchia [1], with present market conditions, especially companies competing through production cost, lean approach is central and crucial. Lean approach, targeted at improving operational performance and attaining customer satisfaction, is permeating into the manufacturing industry globally where business leaders are implementing the approach at different operational areas in their organization for operational improvement purposes [2-5]. For example, through a survey conducted by the EEF Productivity Survey [6], it is discovered that almost 50% of UK based companies adopted lean approach in some part of their production facilities. Referring to the IW/MPI Census of Manufacturers [7], about 70% of manufacturers in the USA have implemented lean approach aiming towards operational improvement. From an exploratory study conducted by Lila [8] on the status of lean concepts in Automotive Manufacturers in the Eastern Region of Thailand, the researcher found that 61.8% of the responded firms have implemented lean approach mainly in their production, planning and warehouse operations and 58.6% from the remaining firms are in the planning stage of incorporating lean approach in their processes.

Originating from the automobile industry, the captivity of lean approach has considerably extended from the heavy manufacturing industry to numerous industries such as banking, mining, public service, hotel, and health care [9-16]. According to Gershenfeld [17], competitive leaders from various sectors of the economy considering the lean approach as one of the central success factors such as Toyota for establishing high quality product and continuous production flow, and Dell for providing customized personal computers in high volume. Lean approach is an outcome of manufacturing leaders acknowledging the importance of customers' satisfaction and the necessity of responding rapidly towards customers' needs [18]. According to Womack et al. [19], the manufacturing approach emerged by eliminating the idea of mass production where the latter is not designed to deliver a wider range of products produced in smaller batch quantities. Lean approach aims towards serving customers with the exact products or services demanded with higher quality, lower price and shorter respond timely manner [20-23].

Basically, the lean approach centered on the philosophy of continuously improving process performances by systematically eliminating waste [19,24-26] which aligns with the principle of

economics, a company must continuously identify and eliminate the non-value adding activity within its organization, introduced by Marshall in 1961 for organizations to regenerate and survive in business. Building towards a customer oriented business, the approach creates the culture of being 'fit' throughout the entire enterprise starting from the shop floor to the board room and involves suppliers, partners and customers as well in the effort [27]. Referring to Womack and Flinchbaugh [28,29] one must not just limit his or her view on the approach as just waste elimination, but necessitates perceiving it positively and aligning it with how an organization thinks and works in terms of communicating, organization structuring, using resources, and employees behaving. The lean approach promotes the need among organizations to continuously understand and differentiate between value adding activities and non-value adding activities from the customers' perspective in the processes of creating and delivering a product or services, and to remove constantly those activities that are perceived as non-value adding. Literatures, in general, review lean approach from two perspectives which are strategic view centering on the principles defining lean approach and tactical view centering on the practical aspects associated with the implementation of the approach. Reviewing from the strategic standpoint, Womack and Jones [30] expressed that the lean approach stress on creating an absolute focused thinking on how to eliminate waste in the process of delivering value to customers at an enterprise level by inducing lean thinking in the manufacturing system. According to Womack [31], to institutionalize the lean principles, appropriate transformations in corporate culture, practices, processes, and management are required, extending beyond the manufacturing floor. Set of tactical engineering and management techniques, methods, and practices that are parallel with lean philosophy are united in an integrated system and geared towards eliminating waste and maximizing the flow of value added activities in the process of producing a product in the pace of actual customer demand [32]. However, the relevancy of LT in the current environment is often questioned. Referring to Lean revisited: Taking a fresh look at

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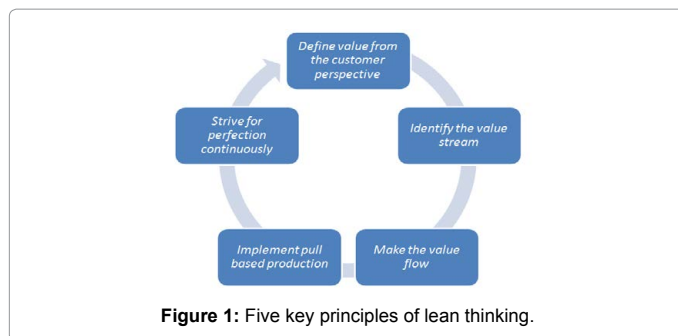


Figure 1: Five key principles of lean thinking.

lean manufacturing strategies [33], the author asserted that the concept is still very relevant to current business practices but need to innovate and reform itself to align with organizational shift. The objective of this paper is to review and discusses in detail the underpinning concept of lean thinking.

### Lean thinking

In the book “Lean Thinking: Banish Waste and Create Wealth in Your Corporation”, written by Womack and Jones [30], both authors approached the lean concept from a general perspective by extending the base of the concept from a functional level to the business level. The authors referred lean thinking as the “way to specify value, line up value creating actions in the best sequence, conduct these activities without interruption whenever someone requests them, and perform them more and more effectively”. Five key principles of lean thinking (LT) were introduced to address the various challenge occurs within and between business units from the differences in business culture and management thought process. The key principles contracted in LT are:

- 1) Define value from the customer perspective,
- 2) Identify the value streams,
- 3) make the value flow,
- 4) Implement pull based production, and
- 5) Strive for perfection continuously. The key goal of those principles (Figure 1) is to establish a perfect value stream by continuously identify, and eliminate activities that are considered waste and focus on activities that truly create value.

### Lean thinking principles

The first key principle of LT is to define value from the customer perspective. The principle conducts organization to evaluate and reconsider on who are their actual customers, and what those customers regard as value. The principle emphasizes on defining value from the way a customer’s perceive it as customers ultimately decide the value of a product or service [34,35]. Referring to Emiliani [36], this way of thinking differ from the common practices used by most companies where they generally tend to specify value from a departmental point of view such as research and development, engineering and finance. Defining value is the means of identifying the form, feature, or function that a customer is willing to purchase in the circumstance where they can’t perform the required task on own or without investing considerable cost or time [37,38]. Womack and Jones [30] stated that enterprises need to “define value precisely in terms of specific products with specific capabilities offered at specific prices through a dialogue with specific customers”. This urge enterprises to understand and define the aspects of a product or service are valuable or not from a customer

perspective, and fulfill their demand by delivering what they want to purchase [39]. According to Howell and Ballard [40], the defined value would establish the objectives for each of the actions surround from designing until delivering a product to the customer. However, Emiliani [36] stated that the process of understanding and accepting the value from a customer point of view mostly would demand an enterprise for a comprehensive reorganization of currently practiced business processes and organization culture. For example, companies may need to restructure the product line by reorganizing managers and employees into units that base on the product.

The second principle of LT is ‘identify the value stream’. Value stream is a concept distinguishes itself from the traditional supply or the value chain concept. The former is a focused view on the value adding process, referring only to the specific activities that involved in adding value to the creation of a specific product or service in an organization, whereas the latter includes the complete activities that demanded in the organization [10]. Womack and Jones [19] defined value stream as the set of all specific actions required to bring a specific product through the three critical management tasks of a business unit, which are (Figure 2):

- Problem-solving task

This task involved with the process of working through and finding solutions for issues occurs from a conceptual design until the launch of a product.

- Information management task

This task engages with the organization and coordination of information related to the order taking process until the delivery of a product successfully to a customer.

- Physical transformation task

This task engages directly with the physical acquisition of raw materials and transforming those raw materials into finished products and deliver it in the hands of customers.

‘Identify the value stream’ principle drives organizations to

- 1) Review and identifies all the activities involved in creating a product,
- 2) Determine activities that add value, and
- 3) Eliminate activities identified as waste in a value stream [41].

The process requires an organization to analyze their value stream and identify all the direct and indirect activities, both value-adding and non-value adding activities that are currently required to convert raw materials into final products and deliver it to the final customer [42].

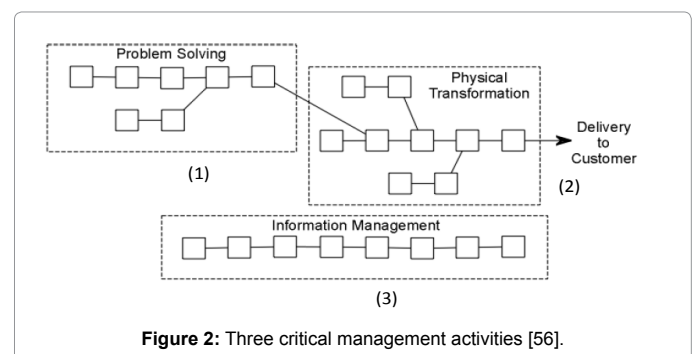


Figure 2: Three critical management activities [56].

Once all the associated activities are identified, the management team needs to determine which activities in the value stream add value from a customer perspective and cluster those activities into two categories, value-added activities and non-value-added activities [38].

Womack and Jones [30] defined value-added activities from a manufacturing context as “steps that actually transforming the fit, form, or function of the raw material, and bring it a step closer to the finished product”. From a general context, Liker and Lamb [43] expressed value-added activities as the efforts invested in transforming an input into an output that a customer wants. Meanwhile, non value-added activities relate to the efforts invested in the same transformation process, but do not add value to the output from a customer point of view. Jolley [44] referred non-value added activities as “the inhibitors of a system in the form of waste, variability, and inflexibility that add cost in terms of time and or expense that do not add value to the customer”. In general, the non-value added activities can be classified into two subcategories that are: 1) unavoidable non-value added activities and 2) avoidable non-value added activities [45]. The former represents wasteful activities that exist in a system due to the flaws underpinning current structure of the system and the latter are the wasteful activities that are unnecessary and avoidable within the current structure of a system. Citing to Ohno [46], Shigeo Shingo expressed both state of thinking clearly by stating in the process of fastening a bolt, only the last turn of a bolt is considered a value added activity as it tightens the bolt. Meanwhile, turns performed before the last turn are just movements that do not add value and unavoidable because it must be done under the present work conditions. Aligning with Shigeo Shingo thoughts, Ohno [46] identified 7 types of waste commonly occur within a manufacturing system, which are overproduction, inventories, unnecessary processing, non required motions, defects, waiting and transportation. In addition to the types of waste outlined by Ohno in 1988, underutilized people was added along to represent the improper utilization of human knowledge, skills and abilities [47-49].

Value stream mapping is a tool proposed to determine activities in a value stream add value within and between a product transformation process and map an optimal value stream [30,50-52]. Howell and Ballard [40] referred value stream map as the process flow charts that identify specific action releases work to the next operation. The chart facilitates in revealing issues hidden in current approaches, brings choices to the surface and raises the possibility of maximizing performance by seeking an optimal value stream for the future. Value stream map uses pictorial to logical representations the current state of a value stream before all the improvement measure and future state of a value stream after the intended improvements are made [53]. Referring to Rother and Shook [54], by mapping out the current state and future state of a value stream, enterprises will be able to identify the assumptions behind current work processes and challenge each activity in a value stream to its relevance in adding value from a customer point of view.

Lastly, activities that are identified as non value-added activities in the value stream need to be eliminated as a step towards raising the possibilities of maximizing the value stream performance. According to Moore and Scheinkopf [39], organizations need to eliminate non value-added activities with the possibilities of being removed from the current value stream and those unavoidable non value-added activities need to become targets for future improvement. They also expressed that by eliminating non value-added through an in-depth process review, organizations will be able to reason and provide solutions to unsolved problems that exists in a process, and assist in surfacing

real problems that were hidden beneath the unsolved problems and hindering the performance of the three critical management tasks. According to Emiliani [36], the act of removing wasteful activities in a value stream would aid in optimizing the business process and increase an enterprise capability. Bozdogan [55] stated with the elimination of wasteful activities, not only an enterprise may reduce the cost of production, but also would increase the efficiency of the business and improve their bottom line, both the short and long run.

The third principle of LT is the introduction of flow in the remaining value-added processes after eliminating the obvious wastes in a value stream. To reduce the production cost, management tends to focus on improving workstation efficiencies such as improving machine utilization rates rather than product value flow where the actual attention is needed [32]. Making the flow principle urges management to recognise the need for flow in a value stream. According to Lian and Landeghem [35], the basic concept of the term flow is “to make parts ideally one piece at a time from raw materials to finished goods and to move them one by one to the next workstation with no waiting time in between”. The flow in a value development process where the components of a final product should be in a constant and smooth motion from station to station without interruption or minimum waiting time in between with the intention of achieving zero inventories between the value development processes, efficiently moving work in process quickly and smoothly, eliminating sub-optimized functional groups that are not contributing to the ultimate output [34,40,56]. However, the process of transforming from a conventional manufacturing to a flow based production is a challenge itself. Radical transformation and continual improvement are essential to establish a smooth flow in the operation [57].

The fourth principle of LT is the pull based production principle, which is probably the most counterintuitive of LT. Once an enterprise is engaged with the first three principles, pull principle is the next important aspect of LT in ensuring customers' receive their desired product or service when they want it. In a simple term, Womack and Jones [30] defined the concept of pull as to “no one upstream should produce a good or service until the customer downstream asks for it”. This principle is indeed contrast with the traditional push approach in manufacturing. Askin and Goldberg point out push as a concept that basically relies on accurate and timely demand forecast to establish the production rates and inventory levels. In the event of improper planning or inaccurate data manipulation to coordinate workstation activities could cause the accumulation of inventory between workstations or workstations idly wait for parts. Quite the opposite, pull assures continuous flow in the production process by associating actual customer orders with the production rate. The upstream operation in a value stream reacts only to the demand laid by a downstream operation [58]. For example, production parts are moved to the next workstation only when they are requested by the succeeding workstation. Womack [30] expressed that a truly Lean based enterprise need to incorporate pull concept in their system in ensuring no waste in term of time, capital or effort is made. According to Heizer and Render [59], by synchronizing the demand of upstream and downstream, manufacturers will be able to control the production rate to the actual customer demands and produce only products that are sold, not produce to stock. Segerstedt agreed that pull principle based production systems are less likely to accumulate inventories between operations since parts are only realized to the following operation if a request is made to the preceding operation. However, Cook and Graser [30] stressed out that, in order to make a pull based production system to work successfully, a considerable collaboration with customers is

required to understand their needs and expectations, and suppliers to ensure required materials are delivered accordingly to the demand.

The final principle of LT is constantly pursuing towards perfection. Referring to Emiliani [36], with the implementation of the first 4 principles to a great degree, enterprises will be able to strive for perfection as the activities in a value stream became more transparent than before. Referring to Womack and Jones [30], Gupta [60] stated that this principle encourages management to continuously explore new opportunity for improvement surfaced from pursuing the 4 principles as there is no end to the effort of reducing effort, time, space, cost, and mistakes in a value stream. Citing from McDonald, the principle of striving for perfection continually aims at establishing the thinking among Lean believers that waste elimination in a value stream is a continuous process, not a one-time event, while delivering exactly what a customer requested and not at attempt slightly better than their competitors. The principle basically indicates that enterprises need to continuously iterate their way through the 4 principles until all the non-value-added activities and wastes are removed from the value stream [61]. With the principle, the culture of constantly search for opportunities to improve operational efficiency, reduce costs and improve product quality is induced in an enterprise. Here, according to Dettmer [56], the questions of why an enterprise didn't manage to get their action right at the first time attempt should be discarded since the potential for further improvements in business operations always exist and a complete perfection state can never really be reached.

## Conclusion

LT principles are an amplification of LT definition that is how value is generated efficiently and effectively in a production system overall by remaining focused on the customers and core competencies. The five LT principles guide management in the process of developing a lean based enterprise and create a continuous journey towards waste elimination by working together and revisiting each activity in a value stream to identify opportunities for further improvements. The level of innovation and improvement driven by the lean thinking in manufacturing industry eventually has encouraged management teams from other industries to consider and implement the 5 key principles in their organization.

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