# Factors Influencing Implementation of Lean Manufacturing: Case on Manufacturing in Indonesia

**Hendro Lukman and Susanto Salim**

**Abstract** To be a winner in today's business world means working efficiently. Efficiency as the primary key should be done on all aspects in a company. Companies increase efficiency in the production meanwhile they must maintain or improve product quality. A method to increase efficiency in the production is by applying Lean Manufacturing. In maintaining quality, they can implement Kaizen, Quality Management System, and others. The purpose of this study is to tell how Just in Time, Kaizen, Cycle Time, and Lead Time with Quality Management System as moderating variables can influence Lean Manufacturing. The research was done in two phases; the first phase is to test the influence of Just In Time, Kaizen, Cycle Time, and Lead Time as independent variables on Lean Manufacturing. The second phase is to test the influence of all independent variables on Lean Manufacturing with Quality Management System as moderating variable. Results from the first phase show that Just In Time and Cycle Time do not have any effect on Lean Manufacturing. The second test showed that Just In Time still does not effect on Lean Manufacturing, while Kaizen and Lead Time have an influence with positive direction on Lean Manufacturing. Finally, Cycle Time has an influence on Lean Manufacturing with negative direction.

**Keywords** Lean manufacturing management · Just in time · Kaizen · Cycle time · Lead time · Quality management system

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# 1 Introduction

Currently, business competition is getting harder and heavier. Companies compete in product development, product features, and even in the marketing strategy. A lot of things can be done by management to win business competition, improve and even grow the business. Many elements can make the company superior to its competitors such as the price, quality of goods, the speed and accuracy of order fulfillment, and others. All can be achieved if the management run the company efficiently. It can be said that most of the companies are still working on developing their effectiveness and efficiency. This means that they are trying to build stable running processes before targeting the objective. One way to improve efficiency is through lean manufacturing practices such as machine setup time reduction. To improve efficiency is an activity that has added value by making the process shorter and labor utilization, waste reduction, utilizing tools and space. Also by avoiding defective products and waste in the production process (Al-Matarneh 2012). Manufacture of products with precision and efficiency will produce a good product and meet the requirement and customer satisfaction at a reasonable price. With the fulfillment of desires, requirement and customer satisfaction, the company can survive and grow.

# 2 Literature Review

## *2.1 Lean Manufacturing*

Lean Manufacturing concept is a concept of efficient production taking into account all available resources to obtain economic value without waste, resulting in low product prices while maintaining quality with a shorter time. Lean manufacturing is also viewed from the angle of the customer. One of the main objectives of lean management is the reduction of variability and non-value added activities that increase output (Shin et al. 2002).

The term lean was introduced by Krafcik (1998) that came from the manufacturing industry in Japan. With less natural resources and high labor cost in Japan, manufacture a product in Japan should be efficient and effective. One thing to improve the efficiency in producing product is to eliminate waste. Waste is cost. In Japan, lean means manufacturing without waste. Waste ("muda" in Japanese) in manufacturing has seven types: waste from overproduction, waste of waiting time, transportation waste, inventory waste, processing waste, waste of motion, and waste from product defects (Rahman et al. 2013). To reduce or to minimize the wastes, they should look for concept or method to make more efficient in manufacturing. One good concept in manufacturing is leaning the production process. This concept is lean manufacturing. The lean manufacturing is much more than a technique; it is a way of thinking and a whole system approach that creates a culture in which

everyone in the organization continuously improve operations (Naveen et al. 2013), so that lean manufacturing focuses on improving the throughput of a facility, reducing the lead time, inventory, defects, rework, and process wastes, and ultimately improving financial savings and customer satisfaction (Melton 2005).

Lean manufacturing is a production system that cuts manufacturing practices as pull-production system such as set-up time reduction, Just In Time, and quality management (Shin et al. 2002) which concentrate on the elimination of all waste (Womack et al. 1990) resulting in high operational performance (Sha and Peter 2002). Just as the research by Cua et al. (2001) in Shin et al. (2002), lean practices such as set-up time reduction and pull-production systems increase cost efficiency. High operational performance should be analyzed by specific multidimensional practices that are causally related to each performance dimension Flynn et al. (1995). In this case, the factors to consider are kaizen as the foundation for the implementation of lean manufacturing, followed by just in time as a material or inventory resource efficiency improvement, cycle time, and lead time which will directly improve efficiency in manufacturing.

## 2.2 *Just in Time*

The Lean manufacturing is not only to eliminate wastes, but also eliminate non-value added activities. According to pull-bases production system, the production flows should be designed in order to define the inventory level, especially for work in process inventory which is one of the company goal to reduce it (Nenni et al. 2014). Another company goal in inventory level is to reduce raw materials and finished goods levels. To meet company goal in proper level inventories, company may implement just in time method. Just In Time is defined as "Production of the minimum number of units in the smallest possible quantities at the latest possible time, which eliminates the need of the Inventory" Does not mean to produce on time, but to produce "Just in Time" Modi and Hemant (2014). Therefore, just in time is not only to focus on minimize or zero raw material inventory, but also to minimize work in process inventory and finished goods inventory. Hold much inventory is wasting money or liquidity.

Just in time is a control system on the production and inventory where material units are purchased and manufactured in accordance to meet customer demand. The company buys raw material based on production needs to produce customers' order. The most important in implementing Just In Time is role of supplier. This system cuts inventory levels at each stage of storage costs. This system has been characterized precisely from the arrival of raw materials from trusted suppliers and binding contracts to delivery of raw materials in time, manufacturing accuracy to maintain high quality, to delivery orders to customers on time and at the lowest possible cost (Alfadel et al. 2007). Therefore, supplier commitment plays an important role in order to ensure production lines which operate smoothly and efficiently. There are five important criteria when choosing suppliers includes

quality, willingness to work together, technical competence, geography, and price. The aim of Just In Time is to eliminate stocks rather than move them to another point in the supply chain (Rahman et al. 2013).

Just In Time cannot be implemented if it does not involve other factors such as machine, software, and human. Just In Time works hand-in-hand with the machine set-up time reduction and quality management as part of an overall strategy to reduce inventory and optimize resources more efficiently (Kannan and Tan 2005). With reduced set-up time and quality management it is aimed to eliminate all types of waste (Kannan and Tan 2005) Just In Time is one of the important components in applying lean management. By eliminating waste it will simplify the production process (Shin et al. 2002) because there is no obstacle in the process of material flow. Therefore, it said that Just In Time is one of the elements constituted in total quality management (hereafter termed as Total Quality Management) system (Flynn et al. 1995).

## *2.3 Kaizen*

KAIZEN means Continuous Improvement. Kaizen is a word from Japan. Kaizen come from two words, i.e., Kai and Zen. KAI means take apart and make new, and ZEN means think about so as to help other. Kaizen philosophy for everything, it is not a big achievement if something successes according to the plan in our lean because such a thing has always been implemented (Modi and Hemant 2014). The philosophy of kaizen is a continuous improvement which is the starting point and is directed to all downsizing initiatives (lean) (Krafcik 1998). Meanwhile, in the philosophy of continuous improvement, it recognizes no end to the reduction of effort, time, space, cost, and mistakes (Tapping et al. 2002). The important thing in implementing kaizen is to involve all employees at every level of the organization. Kaizen, as a tool, is integrated in the normal day-to-day activities with a focus on waste elimination, creating standards and having clean workplaces, and organize them. Improvement made through kaizen is generally small and subtle, but the results in the long term will be large and long-lasting (Anvari et al. 2011). Kaizen program helps companies create a foundation for the company to sustain the improvement process of the company life (Ortiz 2006). The Kaizen improvement of technological manufacturing, approach systematic steps to improve technological process: process mapping, analyze the process, and redesign the process (Boca 2011).

There are five steps to improve workplace practices that facilitate visual control and lean implementation, it called 5S. The 5S is a workplace organization technique. It is a way to involve associates in the ownership of their work-space. The 5S is a lean tool which consists of Seiri, Seiton, Seiso, Seiktsu, Shitsuke taken from Japanese language which plan Reduce waste hidden in the plant, Improve quality and safety, Reduce lead time and cost, Increase profit (Modi and Hemant 2014). If the principles are applied correctly, significant results can be achieved in the

manufacturing process by understanding the use of value stream maps, performing time studies, utilizing spaghetti diagrams, and focusing on incremental changes to the process through the use of Kaizen events (Tapping et al. 2002). Kaizen is a systematic way to improve the workplace, processes, and products through production line employee involvement (Tapping et al. 2002) and helps to create and maintain the efficiency and effectiveness of work area (Modi and Hemant 2014).

One of the mechanisms used in the implementation of lean manufacturing is Kaizen (KE), according to Kirby and Greene, Vasilash: "a focused and structured improvement project, using a dedicated cross-functional team to improve a targeted work area, with specific goals, in an accelerated timeframe" (Glover et al. 2011). Kaizen is making workplaces conducive and put the necessary working tools in the workplace neatly arranged which can create a productive working atmosphere so that activities undertaken in the production process have value added. In other words, kaizen eliminates all activities that have no added value. In line with lean manufacturing, a process that does not have added value should be eliminated. Therefore, the Kaizen method and technique are valuable instruments that can be used to increase productivity to obtain competitive advantage and to rise the overall business performance on a tough competitive market (Boca 2011).

## *2.4 Cycle Time*

Cycle time is the time used to complete one cycle job sequentially as a consequence of working standards that have been determined. This activity is not only the nature of the operation, but also control and dispatch activities which also affect cycle time (Bharath and Prakash 2014). Cycle time is measured by time; time is one measure of efficiency in relation with the decision to control the process. It should also be considered how decisions and equipment properties can affect cycle-time (Bharath and Prakash 2014), beside human and availability of material, it is necessary to understand the features and how the equipment works, not only pay attention to the working procedure. By knowing how the equipment works, it helps to reduce the cycle time, which is one of the component of internal lean practices to set-up time reduction (Kannan and Tan 2005). The shorter the cycle time required to complete the work with the same results, or becoming optimal, then higher the efficiency.

Cycle time is used to assess the environmental aspects and potential impacts associated with a product, process, or service (Urs et al. 2014). It includes any movement of materials that does not add any value to the product, such as moving materials between workstations (handling). Transportation between processing stages results in prolonging production cycle times, the inefficient use of labor and space (El-Namrouty and Abushaaban 2013). Any movement in the firms could be viewed as waste (El-Namrouty and Abushaaban 2013). Waste can be classified into eight categories in term of cycle time, such as (1) motion: movement of people that does not add value, (2) waiting: idle time created when material, information, people,

or equipment is not ready, (3) correction: work that contains defects, errors, reworks mistakes, or lacks something necessary, (4) over-processing: effort that adds no value from the customer's viewpoint, (5) over-production: producing more than the customer needs right now, (6) transportation: movement of product that does not add value, (7) inventory: more materials, parts, or products on hand than the customer needs, and (8) knowledge: people doing the work are not confident about the best way to perform tasks (Tapping et al. 2002). Therefore, to improve cycle time is not only to consider the ability of machine but should consider eight points of waste.

Related to lean manufacturing, Lean manufacturing is a variation on the idea of efficiency based on optimizing flow toward increasing efficiency, decreasing waste, and using empirical methods to decide what matters, rather than uncritically accepting pre-existing ideas (Tapping et al. 2002). Flow in producing a product is the most related to cycle time. The principle of flow manufacturing is producing an item at a time at a rate equal to the cycle time. The successful implementation of flow manufacturing needs should be standardized and less-expensive user friendly (Sundara et al. 2014). Hence, cycle time is in line with the concept of lean manufacturing which eliminates the physical process by utilizing equipment features to improve efficiency. Improving efficiency in production creates effectiveness of lean manufacturing implementation, so that it helps streamline operations and increase value as perceived by customers (Araidah et al. 2010).

## *2.5 Lead Time*

Lead time is a latent period between the initiation and execution of a process. Lead time in manufacturing can be started from the receipt of orders from customers until the goods are ready for shipment, or from the receipt of orders in production until the goods are finished (Kader and Aker 2014). Lead time can be defined as total time required to manufacture an item, including order preparation time, queue time, set-up time, run time, move time, inspection time, and put away time. It is the time interval between the initiation and the completion of a production process (Urs et al. 2014). Lead time involves machine and equipment (MAE) and manpower were defined for producing (Bharath and Prakash 2014).

To evaluate the lead time on a set of process is used as Value Stream Map. The Value Stream Map is the entire set of activities running from raw material to finished product for a specific product or product family. Value stream maps are powerful visual tool used to identify waste and understand the flow of material and information. Value stream maps show all actions required to deliver a product (Modi and Hemant 2014). Value stream map is the techniques that bring all the processing steps at one place. It shows the big picture of shop floor rather than individual processes and improving each area at the production line. It is used to draw attention to different wastes and eliminating them in future state map (Saraswat et al. 2015). To review the efficiency lead time, the first step is company makes current to flow which existing happen in the production floor. Then,

according to the current-state map, lean team can calculate how much time non-value added the company spend on it (Chen and Ronald 2012) and change the flow to minimize the time of producing by eliminating non-value added activities.

Therefore, lead time is also an activity involving planning and the actual control on the production process, so that lead time can also be a tool to summarize the process via elimination processes that do not add value. Manufacturing lead time is shorter as production efficiency improves through eliminating activities that do not have added value. However, operates by the cost reduction principle, meets quality cost and delivery requirements, and wants to eliminate all waste from the customer's value stream surely need to learn about lean to succeed in the market (Tapping et al. 2002).

## 2.6 *Quality Management System*

Quality management system is a set of documented procedures and standard practices that make up a system which aims to ensure conformity of the quality of products or services produced. Quality Management System contains various elements or all elements in the organization. The system consists of the functions of planning, organizing, implementation, and control. So the quality management system contains activities of how to create quality as planned, set forth in the organization by preparing written procedures and conducting control of the implementation.

Quality Management System is the part of Total Quality Management. All of them talk about system to manage quality of product from beginning to ending, that is from receiving order from customer until shipping goods to customer. Total Quality Management as an approach to management characterized by guiding some principles or core concepts that embody the way the organization expected to operate, which, when effectively linked together, will lead to high performance (Anvari et al. 2011). Total Quality Management can be classified into two broad categories or dimensions such as social or soft Total Quality Management and technical or hard Total Quality Management (Anvari et al. 2011). The social techniques are centered on human resource management and emphasize leadership, teamwork, training, and employee involvement. The technical issues reflect an orientation toward improving production methods and operations and seek to establish a working method through the establishment of well-defined processes and procedures to make possible the constant improvement of goods and services to customers (Bou-Llusar et al. 2009).

On the other side, implementation of lean manufacturing needs human approach. According to Chen and Ronald (2012) the first step to implement lean is training team members about lean principles. The success of implementation of lean manufacturing practice critically depends on employee participation, proper training, and commitment from the top management (Manoj et al. 2014). Hence, an attempt has to be made to integrate Quality Management System and Lean

Manufacturing principles and requirements. An integrated system is to be developed right from the stage of infancy of the organization (Gajendran and Kumar 2011). By implementing quality management system right from the early stages of production helps the organization to have clearly defined roles and responsibilities, process and interfaces thereby avoiding unnecessary confusions (Gajendran and Kumar 2011), and easier to implement lean manufacturing.

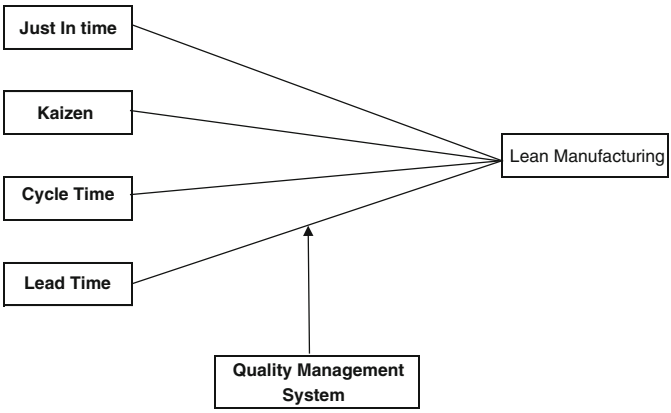
Thus, if the quality management system is run in line with the vision/mission of the company, it will create a stable quality standard. With effective quality management system, a company will naturally reduce processes that do not have added value, for example, by setting a certain quality to suppliers so that companies can apply the Just In Time concept. Then, the acceleration occurs in the production process and it becomes more efficient. Relationship with kaizen and using the same mapping process (Kedar et al. 2008) improve efficiency. Relation with lean manufacturing is a focus on improving the entire value streams and Quality Management System is technically oriented to the increase of production methods and operations, and establish methods through setting well-defined processes and procedures to make possible the constant improvement of goods and services to customers (Chen and Ronald 2012).

## 3 Research Methodology

Variables used in this study consist of Just In Time (JIT), Kaizen, Cycle Time (CT), Lead Time (LT), Quality Management System (QMS), and Lean Manufacturing (LM). Just In Time, Kaizen, Cycle Time, Lead Time, and Quality Management System are the independent variables, while Lean Manufacturing is the dependent variable. This research was conducted in two phases. Phase I is to analyze the influence of JIT, Kaizen, Cycle Time, and Lead Time on LM. Phase II is to analyze the influence of Just In Time, Kaizen, Cycle Time, and Lead Time on Lean Manufacturing with Quality Management System as moderating variable to determine whether Quality Management System will strengthen or weaken the independent variables of lean manufacturing.

Sample used of this research is primary data that collect purposive sample from population. The populations are manufacturing which have implemented Lean Manufacturing, Just in Time, Kaizen, and Quality Management System or ISO 9000 in their production lines more than two years. By implementing those systems more than two years, hopefully a company or subject has experiences and results of the systems can answer the questions. The first step in spreading questionnaires is the researcher asks to company management if they were implementing those systems. A total of 145 questionnaires were spreaded to 17 companies in Jakarta surrounding, the eligible questionnaires to process on this studied only 91 questionnaires. All questionnaires were filled up above by supervisor level. The companies which are participating in this study come from any kind of industries because of the criteria of this study.

Data analysis was done by qualitative method, which is by using the Likert scale questionnaire, followed by the interval successive method, and then used the regression method. The hypothesis model of this research as follows:




The hypothesis of that model as follows:

$H_1$: implementation of Just In time has a positive influence on implementing of Lean Manufacturing
$H_2$: implementation of Kaizen has a positive influence on implementing of Lean Manufacturing
$H_3$: Cycle time has a positive influence on implementing of Lean Manufacturing
$H_4$: Lead Time has a positive influence on implementing of Lean Manufacturing.

## 4 Result and Discussion

After validity test, reliable, classic, and normal test from collected data were done and met the requirement, data continued in regression test.

The test results of phase I are summarized in Table 1.

The test results show that Just In Time and Cycle Time do not affect on Lean Manufacturing but give positive direction, while Kaizen and Lead Time have a

**Tabel 1** Test result of phase I

| | Coefficients | Standard error | *t* Stat | *P* value |
|---|---|---|---|---|
| Intercept | 0.331016 | 2.289737 | 0.144565 | 0.885393 |
| JIT | 0.159886 | 0.104785 | 1.525835 | 0.130715 |
| Kaizen | 0.270351 | 0.088039 | 3.070818 | 0.002857 |
| CT | 0.081523 | 0.09958 | 0.818671 | 0.415237 |
| LT | 0.471536 | 0.12889 | 3.65843 | 0.000437 |

positive effect on lean manufacturing with 95 % confidence level, although all the variables simultaneously have an influence on the implementation of Lean Manufacturing through sig test F.

The second phase is looking for influencing of Just in Time, Kaizen, Cycle Time, and lead time on Lean Manufacturing with Total Quality Management as mediating variable. Do Total Quality Management strengthen or weaken influence of Just In Time, Kaizen, Cycle Time, and Lead Time variables on Lean Manufacturing.

The test results of phase II, are summarized in Table 2.

These results explain that the interaction of Quality Management System and Just In Time show no effect and positive impact on Lean Manufacturing. This means that Quality Management System does not contribute any influence of Just In Time on Lean Manufacturing. The interaction of Quality Management System and Kaizen gives a positive effect on lean manufacturing. It indicates that the Quality Management System contributes to strengthen the influence of Kaizen on Lean Management. The Interaction of Quality Management System and Cycle Time negatively affects on Lean Manufacturing. It indicates that Quality Management System contributes to weaken the influence of Cycle Time on Lean Manufacturing. This research opposite to research who conducted by Singh stated that Cycle time reduce the machines time (Singh and Belokar 2012). Meanwhile, the interaction of Quality Management System and Lead Time has a positive influence on Lean Manufacturing which shows that Quality Management System gives contributions to strengthen the influence of Lead Time on Lean Manufacturing, as same as research conducted by Modi and Hemant (2014), stated that Lean manufacturing provides varieties of strategies of improving performance to compete in this emerging market by improving lead time (Modi and Hemant 2014), Bharat stated that the lead time after the establishment of FIFO, the inventory reduced in the lead time by one day (Bharath and Prakash 2014), and Urs et al. (2014) stated that Lead time reduced from 21–26 days. VSM helps to reduce the non-value added activities. Improved the information flow and process ratio. Converted all process from push system to pull system. It also as same as result of Singh and Belokar (2012) who stated that by implementing lead manufacturing, the obyek of the study had reduced all kinds of wastes.

The limitations of this study especially in gathering data, such as only companies who slightly implement all the system (Lead Manufacturing, Just In time, Kaizen,

**Tabel 2** Test result of phase II

| | Coefficients | Standard Error | *t* Stat | *P* value |
|---|---|---|---|---|
| Intercept | 15.04489 | 1.766081 | 8.518799 | 4.6928E−13 |
| QMS-JIT | 0.000587* | 0.006212 | 0.094523 | 0.9249134 |
| QMS-Kaizen | 0.008168 ** | 0.004882 | 1.673029 | 0.09795574 |
| QMS-CT | −0.01295* | 0.005142 | –2.51746 | 0.01367411 |
| QMS-LT | 0.014396** | 0.007321 | 1.966376 | 0.05248043 |

*Confidence level at 5 % and **Confidence level at 10 %

and Total Quality Management or ISO 9000) simultaneously, and companies reluctant to give the information about the results of implementation or how they run the systems, beside time to collect data. With the limitations of data and ignoring the respondents regarding the theoretical understanding of all variables used as well as respondents taken in certain areas, it can be concluded that the implementation of Kaizen and shortened Lead Time have an influence on the successful implementation of Lean Manufacturing, both directly and supported by the implementation of Quality Management System. However, Cycle Time has no effect on the successful implementation of Lean Manufacturing, but Cycle Time will give negative direction when it is followed by the implementation of Quality Management System. This could be because the Quality Management System that was established and implemented by the company is too complex, rigid, and less flexible to maintain quality, so that to shorten the cycle time, the effect is not eliminating the non-added value activities.

Suggestion for future research, the study will be more interest if research conducted in specific industry such as garment industry, food and beverage industry, metal industry, and so on. The result may be different because the data is more homogen than this study.

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