Lean Manufacturing: A Case Study of a Sri Lankan Manufacturing Organization

Article · January 2011

2 authors, including:

Chandana Perera
Sri Lanka Institute of Information Technology

Case Study

Lean Manufacturing: A Case Study of a Sri Lankan Manufacturing Organization

H S C Perera and D M A Kulasooriya***

This paper presents an application of the Lean Production System in a manufacturing environment. It discusses the most important elements of lean practices through a case study, carried out in a Food processing facility in Sri Lanka, where lean system was implemented. Further it illustrates the impact of lean consumption on bottom-line results of business processes. It was found that leanness of the business process is below the expectation as its process cycle efficiency is around 12.4%. It means that most of the activities (nearly 88%) of the Jar-process consist of Business Non-Value Added (BNV) and Non-Value Added (NVA) activities. Therefore improving this process would bring in a lot of financial gain as well as the lead time reduction.

INTRODUCTION

Toyota Production System (TPS) is a buzzword today in manufacturing circles. It is known as a flexi and cost-effective production model all over the world. TPS was conceptualized by Taiichi Ohno at Toyota Motor Company in 1950s (Motwani, 2003). In fact, TPS is the result of a series of best practices, which have been tested at Toyota Motor Corporation over the several decades. The goal of implementing TPS in an organization "...is to increase productivity, reduce lead-times and costs, improve quality, etc." (Sriparavastu and Gupta, 1997; Sánchez and Pérez, 2001).

Kasul and Motwani (1997) in their study find that companies that employ TPS have benefits such as "reduced lead times, just-in-time management, decreased costs, levelled production, continuous flow production, increased job satisfaction for employees, higher productivity, lower inventories, and higher quality levels." Japanese companies have been able to successfully implement this system and hence been able to reduce the time for turnaround from when the customer orders to delivery and cash received. This reduction in time has helped companies through tough times and helped in maintaining their profitability.

* Professor, Head of Department, Department of Management Technology, University of Moratuwa, Sri Lanka. E-mail: hscp@uom.lk

** Director- Productivity and Management Development, National Institute of Business Management (NIBM). E-mail: kulasooriyadma@yahoo.com

CONCEPT OF LEANNESS

Lean means producing more with less. The concept highlights the importance of less consumption of resources in all aspects of the business i.e., throughout the value creating process. Interest in the concept of leanness has expanded and evolved to include concepts of agility and responsiveness (Soriano-Meier and Forrester, 2002).

Soriano-Meier and Forrester (2002) state that increasingly in competitive markets the concept of leanness is gaining importance for the practitioner since it is an amalgamation of the processes of TQM, Just-In-Time (JIT) management, and computerized aspects of the design process, and factory and supply chain management. Implementing the aspects of leanness takes time and hence getting the gains of the lean concept can be viewed as a strategic process which does not give short-term benefits such as short-term competitive pressures. The concept of leanness is also of interest to the academic since there are few studies which have defined the concept in operational terms or addressed the measurement of its adoption in firms.

Lean consumption paves the way for creating business processes which consume less resource and produce more tangible outputs. A lean process consumes *time* and *materials* only and when the buyer demands (pull system in a lean process). Further lean processes are made up of *actions* that are paid by the buyer. All other possible non-paid actions are supposed to be eliminated. Any action that is not paid by the buyer is called non value added actions. Hence variables of consumption are; time, materials and un-paid activities

Practical application of lean tools provides us with some elegant solutions, which eliminate or mitigate root causes of wasters from the business process. The delivery on demand, one piece flow, pull system and load leveling and six sigma quality are the fundamentals to reduce consumption.

CASE STUDY

The methodology used for presenting the case study is explored in this section. First the research method is explained, followed by a brief description of the company (confidentiality of the company is maintained) and the results are presented.

RESEARCH METHOD

The research method is similar to that used by Kasul and Motwani's (1997) study. The primary approach for conducting this study was the case study method. Interviews, observations and archival sources were the sources from which data was collected. Interviews were conducted with the director of operations, unit managers and quality managers. In person interviews were conducted with those who were most familiar with the manufacturing process. The other sources of data were unstructured interviews from other management and non management personnel during the period of this study.

Observations were made on the shop floor and data were collected by way of a time study. A door to door processing time and lead time were collected to develop the current state map of the process. Value Stream Mapping tools were applied to develop the current sate map and the future state map. Another source of documentation was the archival sources which were used in the research.

BACKGROUND OF THE COMPANY

The company studied was a medium -size food processing facility located in one of the Industrial Zones of Sri Lanka. The company is an ISO-9001-2008 and Hazard Analysis Critical Control Point (HACCP) certified food processing subsidiary of a large conglomerate in Sri Lanka. The Company exports variety of food products made out of locally cultivated vegetables and fruits. Product families of the company are based on the customer requirements. Never ending escalation of operational cost and heavy pressure on prices due to competition in the international markets has resulted in shrinking of its profit margins. Therefore the company has decided to bring in the best manufacturing practices on to the production floor with a view to reduce cost of manufacturing so that it would be able to enjoy a unique cutting edge over its rivals.

In fact the company has been implementing TPS tools in isolation over a period of five years. The company implemented TPS tools such as visual management system through Japanese 5S method, Quality control Circles, Kaizen suggestion schemes, Total productive maintenance and six sigma systems. However, management of the company is of the view that there is a lot of room for improvement in the business processes. In order to realize its true potentials the company has decided to implement the TPS in total. This paper is the study of one of its business processes and the future state of the same after applying the lean principles.

OBJECTIVES OF THE STUDY

The study was carried out with a purpose of achieving following specific objectives.

- Study the current consumption levels (current state) of the process.
- Identify areas where lean consumption principles and tools are applicable.
- Design a new process (Future state) which consumes the least amount of resources.
- Assess the impact of lean consumption of future state on bottom-line results of the Process.

EVALUATING THE DEGREE OF LEANESS OF THE PROCESS AND ITS PRODUCT FAMILY

The major elements of the TPS which are taken in to account in evaluating the degree of leanness and a brief explanation on each follows.

One-Piece Flow: Kasul and Motwani (1997) state that "One-piece flow is defined as moving/making only what is needed, when it is needed...". This minimizes work in process inventory, which in turn enhances efficiency and reduces response time. For line balancing, calculating the takt time is required. In Kasul and Motwani's (1997) study, takt time is defined as the time taken to produce a single component or a complete product based on the demand. The calculation for takt time = operable time per day (in seconds)/required number of pieces per day (Kasul and Motwani, 1997).

Standard Set-Up: The series of steps required for the changeover from one production of one product to another is referred to as the standardized set-up. The worker, machine and the materials are the key considerations in this process. Zero change over time is aimed for with the process being measured from the last good piece produced before the changeover to the first good piece after the changeover (Kasul and Motwani, 1997).

Pull System (Kanban): Kasul and Motwani (1997) state that kanban is a scheduling system, with production instructions that state what materials needs to be replaced or used up in the current process, for the subsequent process to follow smoothly. Minimal inventories and its ability to adjust to demand easily are hallmarks of the system (for a more detailed understanding refer Kasul and Motwani, 1997).

Perfection (Jidoka): Kasul and Motwani (1997) state that "Jidoka is defined as a system of ensuring that defect-free product is passed from one operation to the next. Quality is designed into the operation beginning at the product/equipment design phase utilizing prevention techniques." (Kasul and Motwani, 1997). Two techniques for producing these defect free products are poka-yoke (mistake-proofing) and andon (signaling).

Load Leveling (Heijunka): Kasul and Motwani (1997) state that "Heijunka is a production planning method which evenly distributes the production volume and production variety over the available production time....Heijunka is the overall levelling in the production schedule of the variety and volume of items produced in a given time period" (for a more detailed understanding refer Kasul and Motwani, 1997).

DISCUSSION AND RESULTS

The process in question manufactures more than 50 different items of products and caters to four major buyers. (See Table 1). The process produces both brined products as well as fresh products depending on the season.

PRODUCT FAMILIES

Product Families have been identified based on the type of buyer. It appears that some buyers need specific requirements and process will change accordingly. Hence grouping is done on the basis of the buyers. A family consists of more than 30 different items while the B family is made up of 11 items. C family consists of 03 different items and D family has more than 12 items.

For the study, a product from family A with a net drained weight of 295 + 60 g was selected. It was observed that the process is designed in a straight line from feeding up to shipping. It is made up of seven door to door sub-processes and five of them are manual processes. The manual processes are:

- Feeding of raw materials
- Weighing
- Unloading
- Palletizing and wrapping and
- Labeling

Out of them batch processing was observed at three sub-processes listed below. Others are continuous one piece flow and follow the Toyota Pull principle.

- Feeding
- Palletizing
- Labeling

Table 1: Product Families and Process Requirements

Product Family	Pitch	Process Specialty/Changes
A	Carton	With weighing and labeling
B	Pallet	No labeling, no weighing
C	Pallet	With weighing and no labeling
D	Carton	With weighing and labeling

Further study of the process shows that the Pacemaker activity of the process is filling . It is a continuous process with the highest cycle time. In the pacemaker process; the pasteurizer decides the capacity of the process.

CURRENT STATE MAP

Processing time of each sub-process was obtained after observing the movement of material with a capacity of 3,000 jars from the point of feeding to the labeling. Cycle times, number of workers and total processing time are given in the Table 2.

The total processing time from feeding to labeling for a batch of 3,000 jars is 278 min (nearly 4.5 hr). However, currently there is a cooling process of three hours just after unloading jars from the pasteurizer. As a result labeling is not done on the same day of the production.

TIME CONSUMPTION AND WASTES IN THE PROCESS IN QUESTION

Labeling consumes more time while the filling less time than the labeling time. Since the labeling is a manual process, filling of jars will be the pacemaker as it hits the takt time

Table 2: Processing Times for a Batch of 3,000 Sweet Pickle Jars

Activity	Processing Time (min)	Unit Processing Time (s)	No. of People
Feeding	09	0.19	2
Filling of jars	84	1.68	29
Unloading of jars	68	1.36	2
Palletizing	15	0.30	1
Transport to warehouse	06	0.12	1
Labeling	96	1.92	10
Total	**278**	**5.57**	**45**

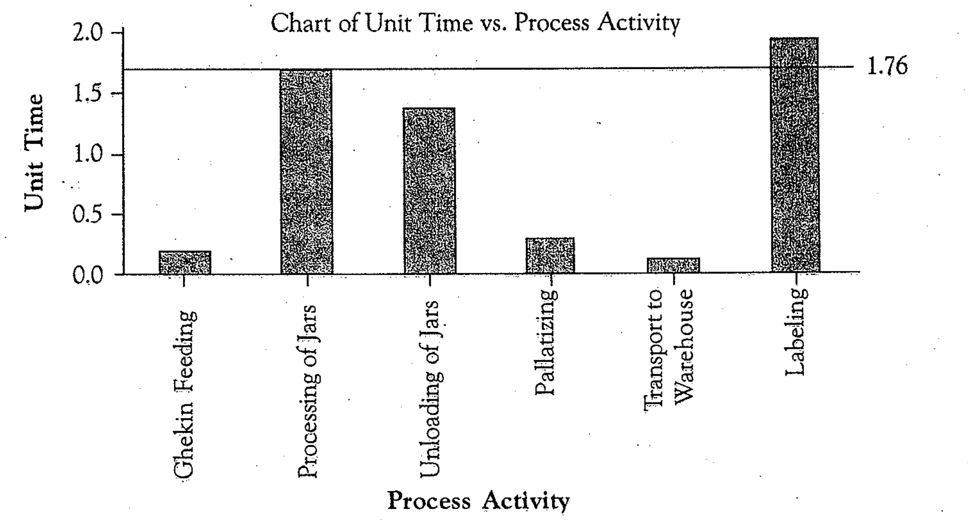
– Time given by the buyer to produce a jar. (1.76 s). It was observed that the process is not a balanced production line and time is wasted at all activities except filling of jars. (see Figure 1).

It was observed that time is wasted at feeding; palletizing and labeling-all are manual processes due to lack of load leveling.

PROCESS CYCLE EFFICIENCY (PCE)

PCE measures the percentage of value added time from the total lead time of a particular Process. PCE can be calculated by obtaining value-added time (approximately the total processing time) and dividing it by the lead time.

Figure 1: Processing Time Against the Takt Time



(It should be noted that time taken from labeling to shipping was not considered in calculating the PCE as the Company has a financial procedure to obtain cash in advance for shipments to be done.)

A lean process is defined as a process with the PCE is more than 25%. Since PCE of the process is 12.34%, it can be concluded that the process in question is not a lean process and there is a potential of doubling the performance.

FUTURE STATE MAP AND FUTURE PLANS

In making the future state map, it is important to look at the following areas:

- Calculate the takt time.
- Identify Pacemaker Process and required capacity based on the takt time.
- Line Balancing to reduce waste.
- Create a flow where ever it is possible by designing a Kanban System.
- Establish the schedule and load leveling.

Before developing the future state map it is necessary to consider the process metrics and to see what opportunities available to make the process lean.

Takt Paced Production

Takt time is the time given by the buyer to produce a unit of output. It has to synchronize the speed of production with the sales.

Takt time = Available time (work time – rest time)/Daily demand

In calculating the daily demand, it was decided to take the full capacity of the pacemaker – Pasteurizer. As this is the bottle neck in the process, it is necessary to optimize the capacity of pasteurizer which ranges from 3,000 jars to 6,000 jars per cycle.

Available time	= 26,400 s
Daily demand	= No of cycles * capacity of the pasteurizer
No of cycle	= Available time/processing time
	= 26,400/5,040 = 5.24 (approximately 05 cycles)
Daily demand	= 5 * 3,000 = 15,000 jars
Therefore, takt time	= 26,400/15,000 = 1.76 s

The process must be able to produce a finished jar at every 1.76 s to meet the daily demand and the full capacity of pasteurizer without overtime. As the standard minute cost of the process is LKR 304 value of the takt time is LKR 8/92. Therefore, producing less than the takt rate, will lose nearly LKR 9 for every unit.

Current Process Cycle time = Total Processing time/Capacity

= 278 min * 60/3,000 = 5.56 s

Currently the process consumes 5.56 s to produce a finished bottle while the required takt rate is 1.76 s. Hence it is necessary to reduce the time taken to take off a finished product from the process. This can be done by reducing the lead time. Therefore it is necessary to create the flow with the following process metrics.

- Pacemaker process and scheduling point: Pasteurizer
- No of Cycles per Day: 5
- Takt Time: 1.76 s
- Capacity: 3,000 jars

Line Balancing of the Process

Due to the imbalance of the process, it is impossible to meet the takt rate of production. Out of seven major processes, labeling, feeding, cooling of jars and some of sub-processes of the jar making such as post sorting of material, weighing of bottles, capping are considered to be major wastages. It was observed that labeling process takes more than the takt time and other processes take less than the takt time. Both ways the company loses until the optimum condition is reached i.e. takt time equals the processing cycle time.

Figure 2: Line Balancing

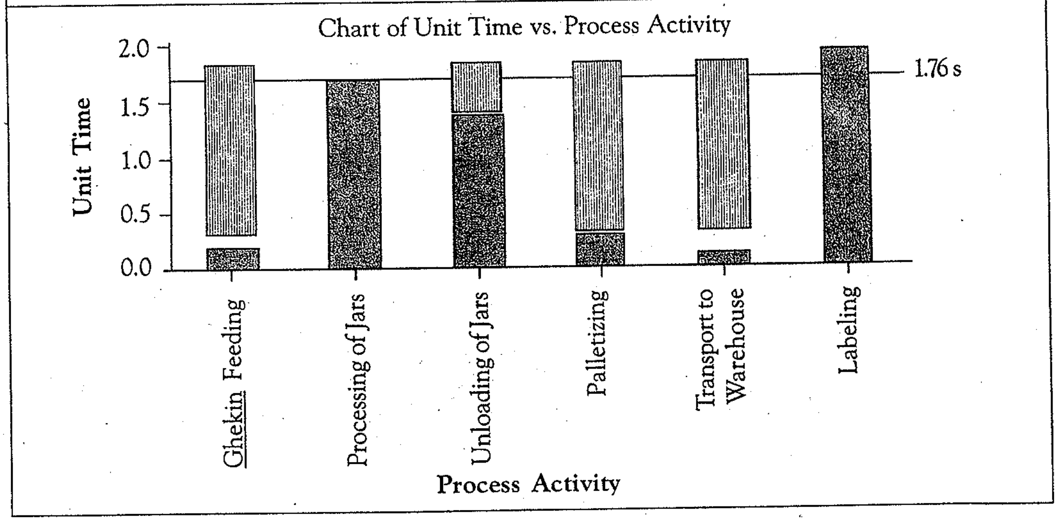


Figure 2 show that all processes except filling of jars are not utilizing their resources up to the optimum level, i.e., the takt time of 1.76 s. Processing time of labeling is also higher than the takt time due to inefficiency. Hence it is necessary to make a balance in all processes of the process in line with the takt time. People and the tools of material feeding, palletizing and transport of jars to warehouse are underutilized.

Labeling process is highly inefficient. The following recommendations are made to streamline the process to meet the takt rate.

Creating a Continuous Flow

The following recommendations have been made after studying the current state map.

- Eliminate Current Labeling process and combine it with palletizing and wrapping:It is a must that labeling process has to be brought back to the jar section and with a new labeling machine. As the current process is located far away from the cell, it is necessary to combine it with palletizing process so that labeling will become a pull process of the palletizing
- Automate the cooling process by using a dehumidifier so that time taken for cooling can be minimized.

  Currently cooling process takes 180 min to condition the jars after pasteurization. This is considerable amount of waste of time in the process due to WIP accumulation at the process.
- Eliminate weighing of jars by installing automatic weigher for lower limit:

  Weighing of jars creates stopovers of the process due to variation of size of material and the skills of people. Due to interruptions of the process, capacity of pasteurizer is underutilized. This has increased the cost of production of a jar.
- Change the supplier of the caps and improve the quality of capping process:

  An interruption at the capping point was noted. It was due to the fact that the quality of caps of the current supplier was inferior. Hence change of supplier is recommended.
- Eliminate Post-sorting by outsourcing or do away the process outside the Process:

  It was observed that post sorting consumes lots of time of Inspectors. Further it creates time traps in the process as well. Hence it is recommended to do away with his process by sourcing graded material.

Process Cycle Efficiency and Savings

Table 3 shows that there is an increase of 11.6% of the PCE and LKR savings of 2 million per annum after implementing the TPS Project.

Table 3: PCE Before and After the TPS Project

Criteria	Before TPS Project	After TPS Project
Actual Processing Time	278 min	164 min
Total Lead Time	2,252 min	687 min

Table 3 (Cont.)

Criteria	Before TPS Project	After TPS Project
Process Cycle Efficiency	12.34%	23.94%
Savings (number of minutes)		114 (278-64)
LKR savings per cycle of 3,000 jars @304.70 per min (for processing time reduction only)		34,735
LKR savings per day (5 cycles per day)		173,679
LKR Savings per Annum from the TPS Project		**2,084,148**

CONCLUSION

It was found that leanness of the process is below the expectation as its process cycle efficiency is around 12.4%. *It means that most of the activities (nearly 88%) of the Jar-process consist of Business Non-Value Added (BNV) and Non-Value Added (NVA) activities.*

However the process has been running as continuous—one piece flow except in a few sub-processes. What is lacking is balancing the line and its load leveling. The study identified areas where TPS principles have not been implemented to improve the process cycle efficiency. As a result, there is a greater potential of financial gain as well as the lead time reduction which brings in lot of positive changes in the bottom-line results.

REFERENCES

1. Kasul R A and Motwani J G (1997), "Successful implementation of TPS in a Manufacturing Setting: A Case Study", *Industrial Management & Data Systems*, Vol. 97, No. 7, pp.274-279.
2. Motwani J G, (2003) "A Business Process Change Framework for Examining Lean Manufacturing: A Case Study", *Industrial Management & Data Systems*, Vol. 103, No. 5, pp. 339-346.
3. Sánchez A M and Pérez M P (2001), "Lean Indicators and Manufacturing Strategies", *International Journal of Operations & Production Management*, Vol. 21, No. 11, pp. 1433-1452.
4. Soriano-Meier H, and Forrester P L (2002) "A Model for Evaluating the Degree of Leanness of Manufacturing Firms", *Integrated Manufacturing Systems*, Vol. 13, No. 2, pp. 104-109.