

The Rationale of Lean and TPM

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Abstract

TPM is mostly regarded as an integral part of Lean. TPM role in maintenance is similar to TQM in Quality. This paper aims to reach a prescription about the best attitude toward Lean and TPM as well as their implementation. Two companies which have implemented TPM without considering Lean were investigated. They had implemented TPM before Lean, but now believe that a company should start with Lean and grow Lean thinking among the employees. In this paper, Lean and TPM comparison proves that they have several common tools and concepts.

Keywords

TPM (Total Productive Maintenance), Lean, implementation, similarities, differences

1. Literature review

Companies implement Lean to achieve better quality, designing the processes which meet customer requirements and expectations, waste elimination (Waste is any activity that does not add value to the product or service.) and lead time reduction (It helps a Lean enterprise deliver the products to the customer in a shorter time and reduce total costs, both direct and indirect) [2]. Since waste elimination is one of the Lean objectives, it is crucial for companies to identify wastes relevant to defects, waiting time, over production (producing more, earlier or sooner than next workstation demand results in larger inventory and costs), transportation (transportation within Work-In-Process (WIP) resulting from weak plant layout and, shortage in understanding of production or process flow), inventory (Excess raw materials, finished products and WIP), unused creativity (Failure in exploiting the knowledge and unique abilities of the employees), movement (Extra transportation due to wrong location of equipments and tools) and over processing (Parts of processes that create no added-value to the product or service) [2,6].

TPM objectives can be classified in seven parts which are higher productivity of equipment and plant comprising; obtaining minimum 80% Overall Plant Effectiveness (OPE) and minimum 90% Overall Equipment Effectiveness (OEE), maintaining the product quality, zero equipment breakdowns by maintaining the equipments at optimal level, zero product defects, zero accidents in all functional areas, reduction in the manufacturing costs and involvement of all employees in the organization [7]. Lean consists of many tools. TPM is based on 5S, which is one of the Lean tools and consists of several pillars that require total employee participation with special focus on the operators. Since the goal of TPM is increase in productivity and efficiency of equipments, this ultimately results in fewer losses and defects, which leads to less waste. Wastage lowering is the Lean goal. Based on this idea, Lean is a culture which paves the way to reach excellence in manufacturing, and TPM is a tool of Lean. The fundamental question for the companies is: Which one should they start with, Lean or TPM? In addition, what is the best prescription for TPM and Lean implementation and exploitation? [1, 3]

2. Case Study: TPM and Lean in Practice

Considering the practical experiences of different companies, which implemented both Lean and TPM help understand the points which may emerge during the implementation of Lean and TPM, whereas, they might not be taken into account before the implementation process.

2.1 SKF Company

SKF was founded in 1907 and is an international company producing a wide range of bearings used in cars, wind mills, machinery, etc. SKF owns manufacturing sites in 130 countries.

The following is based on SKF managers' ideas about Lean and TPM results in SKF:

Lean manufacturing and its origin, TPS, are thinking models. They deal with the question: "How do you look at your organization?"

Lean manufacturing is defined as "*a philosophy that when implemented reduces the time from customer order to delivery by eliminating sources of waste in the production flow*" [10].

There are two different types of organizations in the management's point of view:

Result-driven Management: Lean thinkers like production managers and technicians create methods for process improvements. They plan and dictate how work should be done. One drawback of the result-driven management is that the employees, who actually do the work, are not involved in developing their own jobs. Another drawback is that the result-driven method requires strict control in the organization. The ultimate result of this approach is confusion and less job satisfaction among the employees.

In result-driven companies, managers very often put too much focus on results, parameters, efficiency and their levels and targets but these may be different from reality because the tools are just used without working on Lean thinking [8].



Figure 3: Management by result-driven [8]



Figure 4: Management by means-driven [8]

Means-driven Management: This induces the concept of a supporting organization; everything is done to meet the customer demands. This task is very difficult because sometimes customer demand goes up or down and variable interests exist. Due to this fact, organizations need to increase creativity and competence of the employees. This will result in enhanced working methods, which leads to better results. Since employees create value for customers, their role in the Value Creating Chain (VCC) is very crucial. In the VCC, employees create value and the middle managers like the production managers support them by providing the best conditions to perform their tasks [8].

Result-driven management and means-driven management are both extremes. The best choice is a mixture of them but with more emphasis on the second type.

Benchmarking Scania, SKF tries to send a common message within the organization. The message is “Meeting customer demands”. The customer demands are right amount, right quality, on time delivery and reasonable cost. Establishing a common language within the organization is a difficult procedure. It can be done by defining principles. SKF defined five principles as bases for the bridge (Processes) between the supplier and the customer. The principles are not methods. They do not tell us how to do things and how to reach the goals. They tell us what is important and show the direction. The principles represent a way of thinking [8].

2.1.1 Manufacturing excellence

Manufacturing excellence is about creating a thinking organization. When employees understand what the SKF model of principles is about and why they are important, the organization can start utilizing the employees. For instance if the employees know why demand flow is important, they will cooperate in developing methods to make the company more demand-driven. To utilize all employees' creativity and competence, SKF needs to have a common language. This language consists of principles.

By creating a thinking organization, all employees as well as the management, can use a common language by using the same words and will have the same understanding but everyone will use the words based on his/her task and perspective. By sharing a common understanding of principles, the employees will be involved more and will apply the principles in reality and the principles become more sustainable. The important factor in gaining a common language is mutual trust. A company should trust the employees to do trial and error works under controlled conditions. The employees need to understand the principles, believe in them and have the opportunity to experience by themselves. (Learning by Doing). Ultimately, the employees will be more self-confident and will trust the

managers more. Many companies mistakenly think they can manage everything in the organization by managers and supervisors. With systematic thinking, there will be no need for much supervision. Instead, the managers can spend their time on more value added activities like providing prerequisites for the employees [1, 8].

2.1.2 SKF thinking model

After identifying and defining the principles, companies need to develop methods like 5S, Poka Yoke, Kaizen, TPM, Kanban cord, etc. to fulfill the principles better. Methods are used to fulfill the principles. SKF will follow up the results of using the methods. If the results are not satisfactory, they will change or revise the methods [8].

2.1.3 TPM in SKF

Everything is in the hands of the operators and they should feel ownership of the equipments and take the responsibility. All TPM pillars focus on the operators to make them feel ownership of equipments, obtain skills and take actions to take care of the equipments [1].

2.2 Khavar Spring Manufacturing (KSM)

KSM was founded in 1977 with the aim of manufacturing car springs. It's located in Kaveh industrial zone near Saveh city in Iran. KSM implemented TPM in 2003 and Lean in 2006 [9].

2.2.1 TPM implementation in KSM

Reasons for TPM implementation in Khavar Company [9]:

- A large number of unplanned stops (Breakdown maintenance)
- Long down times of the equipment
- Low equipment efficiency and productivity
- High number of Wastage, “redo’s” and rejects due to poor quality
- Extensive imposed overhead expenses.
- Inconvenient purchases in qualitative, quantitative and on time point of view
- Lack of proper communication between the warehouse, Maintenance and Purchasing departments
- Lack of Multi-skilled and flexible staff
- Problems due to a wide range of products that were produced in low amount
- Lack of listening to the voice of customers and stakeholders
- Lack of job satisfaction
- Lack of preventive maintenance
- Lack of standards for equipment setups
- Critical parts of equipments, which have direct effect on the quality of product, were not identified.
- Lack of total culture for productive maintenance within the organization

2.2.2 Lean implementation in KSM

After TPM was implemented in KSM, the following problems still existed. KSM decided to implement Lean as a response to these difficulties [9]:

- (1) No decrease in Lead time
- (2) No thorough waste elimination especially as of “redo’s”
- (3) Lack of suitable and specific internal and external communication channels in case of incidents and emergences
- (4) Lack of listening to the voice of customers and stakeholders
- (5) No decrease in the number of employees
- (6) Improper lay-out of the equipments and its results like non value adding motions and transportation and, waste of energy
- (7) No inventory reduction
- (8) Insufficient job satisfaction and enthusiasm among the employees
- (9) Unused creativities
- (10) Over production and using a Push system instead of a pull one
- (11) High overhead expenses
- (12) Losses and wastage
- (13) No dramatic decrease in number of incidents, injuries and damages
- (14) Commitment toward changing the organization into a learning type

3. Lean and TPM Comparison

In this part, similarities and differences between Lean and TPM are discussed. These two concepts are compared in the fields of Origin, Theory, Process view, Approach, Methodology, Tools, Primary effects, Secondary effects and Criticism.

3.1 Origin and Theory: The Lean concept came into existence at Toyota Company during the 1930s and mainly after the Second World War. Toyota managers and engineers had benchmarked the Flow Production concept from Ford. After understanding and using the concept, they started to develop and improve it and defined Toyota Production System (TPS) which focuses on elimination of wastes like waste in time as well as resources. TPS is the base of what is known as Lean now. TPM also originated at Toyota but was introduced during the 1970s. Toyota developed the American concept, PM, with focus on Total Employees Participation. Total was added to PM and formed TPM. Production loss is in contrast with right quality, reasonable cost and right time. In this way, Reliable equipment (through TPM) is needed.

3.2 Objective: *“Lean Thinking has always sought reliable processes, but TPM provides the route map to zero breakdowns and continuous improvement in equipment optimization.”*[12]

3.3 Process view and approach: Lean is a discipline that focuses on process speed and efficiency, or the flow, in order to increase the customer value. In Lean, manufacturing improvements are mainly in the form of projects, which are performed by project groups. TPM can also be considered as an improvement project with the aim of decreasing process delays and, involving operators and maintenance teams (teamwork).

3.4 Methodology: Principles of Lean and TPM show the way to reach their objectives. The Lean principles understand the customer value, value stream, analysis, flow, pull, perfection. TPM principles are OEE improvement, Front line asset care as part of the job, Systematic approach toward maintenance, Continuous & appropriate training, early equipment management.

Lean and TPM comparison reveals that OEE is a part of Lean analysis; also, OEE improvement has a positive effect on Flow and Perfection. Front line asset care affects Flow and Perfection. A systematic approach to maintenance serves Lean principles like Flow and Perfection. Continuous and appropriate training helps in understanding customer value by providing external or internal customers with fewer defective products and positively affects Flow and Perfection. Finally, early equipment management facilitates Flow and Perfection.

3.5 Tools: Unlike Six Sigma (6σ), whose tools are statistical in order to eliminate the source of variation, Lean tools are of analytical type. They help reduce and eliminate waste. TPM doesn't have tools like those of Lean but it has some pillars that work in a variety of fields like autonomous maintenance, planned maintenance, Kaizen, Quality maintenance, Office TPM, Training and Health, safety & Environment. Some measuring factors like OEE exist in order to see how much the TPM implementation is successful.

3.6 Effects: Lead time reduction is the main objective of Lean which ultimately results in customer satisfaction as a secondary effect. After Lean implementation, we can also see other secondary effects and changes like a productivity increase and a reduction in inventory. The primary effect of TPM is a decrease in loading time, which is Total possible time minus Scheduled non-production time. This effect positively influences the Availability factor for machines and OEE respectively. More Reliability and efficiency of the equipments as well as a Productivity increase can be achieved as a secondary effect.

3.7 Criticism: The main criticism against Lean is lack of flexibility the concept offers [5]. In addition, the concept actually can lead to delays for the customers [4]. It is a question among the theorists whether Lean, which was developed for manufacturing and distribution situations, is applicable to all industries [11]. TPM needs a long period to be fully implemented. This period includes times for introduction, training, creating TPM groups and implementation of TPM.

TPM tries to increase the margin of companies by increasing the productivity. It only makes the operators and staff maintain equipments without considering working on their attitudes and trying to encourage them to take responsibility and feel ownership of the equipments.

Table 1: Lean and TPM comparison

Concepts	Lean	TPM
Origin	Quality evaluation, Toyota , 1940s	Toyota , 1970
Theory	Removes waste	Remove production losses
Objective	Reliable processes	Zero breakdowns & continuous improvement in equipment optimization
Process view	Improve flow in processes	Decrease process delays
Approach	Project management	Team working and employee involvement
Methodology	Understanding customer value, value stream , analysis, flow, pull, perfection	OEE improvement, Front line asset care as part of the job, Systematic approach toward maintenance, Continuous & appropriate training, Early equipment management
Tools(Methods)	Analytical tools	Pillars including methods like TBM, CBM, RCM
Primary effects	Reduces lead time	Decreases loading time in the process
Secondary effects	Reduces inventory, increases productivity and customer satisfaction	Increases reliability and efficiency of equipment as well as total productivity
Criticism	Reduces flexibility, causes congestion in the supply chain. Lean culture takes a long time to be totally accepted	TPM implementation is a long term process TPM mostly focuses on company margins

4. Conclusion

In order to reach manufacturing excellence in a company, the first step is working on Lean.

Lean starts with revolutionizing the minds of the employees. Many organizations implement TPM before establishing Lean. Experiences show that companies use TPM to increase their productivity and equipment efficiency without trying to motivate the operators to take part in the program actively and voluntarily. Employees may regard TPM as just another improvement program, which serves targets and strategies of the company. A company should raise employees' responsibility and enthusiasm to their jobs. This can be achieved by transferring the message through training sessions and meetings, stating that everyone has his/her share in the success of the company and all roles are important. Furthermore, all employees should obtain a common view, by understanding targets and goals of the company. When this goal is achieved, following steps should be taken:

- (1) Defining the principles of organization
- (2) Public announcement of principles and training for more clarification: This action leads to a common language.
- (3) Forming a thinking organization: This means that all employees should feel free to suggest improvements, make decisions and be productive but only to an extent that poses no threat to the values and reputation of the organization.

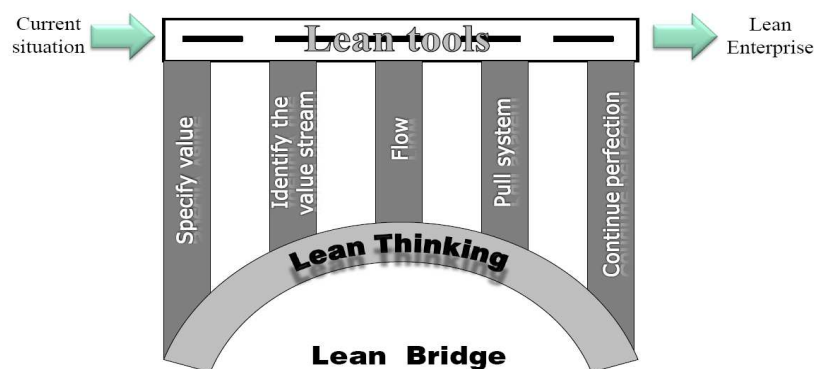


Figure 5: The elements of Lean Bridge

- (4) Employees will discover work shortcomings and ask for techniques for improvements. In addition, the company management may decide to push some new techniques for improvement therefore, the employees should gain enough flexibility to welcome, understand and apply new techniques.

- (5) Lean tools like 5S, JIT, Kanban, TPM, etc., will be deployed with employee participation
- (6) The results will be periodically evaluated
- (7) Reviews, modifications or further implementation of methods.

The success of Lean and TPM implementation is highly dependent on training. Mistake-proofing and problem solving are two competences that are under focus in Lean and TPM and must be highlighted during the training program.

References

1. Arrenäs, L., SKF Company, 2009, *TPM in SKF* [Interview] (Personal communication, May 2000).
2. Bhasin, S. and Burcher, P., 2006, Lean viewed as a philosophy. *Journal of Manufacturing Technology Management*, vol. 17, no. 1, pp. 56-72.
3. Carreira, B., 2004, *Lean Manufacturing That Works*. New York: AMACOM
4. Cusumano, M. A., 1994, "The limits of Lean", *Sloan Management review*, vol. 35, no 4, pp. 27-32.
5. Dove, R., 1999, "Knowledge management. Response ability and the agile enterprise", *Journal of knowledge Management*, vol. 3, no. 1, pp. 18-35.
6. Drew, J., McCallum, B. and Roggenhofer, S., 2004, *Journey to Lean; Making Operational Change stick*. Hampshire and New York: Palgrave Macmillan.
7. Gulati, A.V., and Smith, R., 2009, *Maintenance and Reliability Best Practices*. New York : Industrial Press, Inc
8. Hjelte, M., SKF Company, 2009. *Lean thinking* [Interview] (Personal communication, May 2000).
9. KSM Company, 2009. *Report of Lean and TPM implementation results*. [Word document- translation]. May 2009.
10. Liker, J.K., (1996), *Becoming Lean*, pp. 481. New York, NY: Free Press.
11. Mast, J., (2004). "A methodological comparison of three strategies for quality improvement", *International Journal of Quality and Reliability Management*, vol. 21, no 2, pp. 198-213.
12. McCarthy, D., and Rich, N., 2004, *Lean TPM; A blue print for change*, foreword. Oxford, U.K.: Butterworth-Heinemann.