LEAN PHILOSOPHY: IMPLEMENTATION IN AUTOMOBILE COMPANY

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Abstract: *Lean manufacturing system works in every part of the value stream by reducing waste in order to reduce lead time, cost, brings in more sales, and remain competitive in a growing global market. This research focuses the implementation of lean philosophy in automobile company with emphasis on arrangement of resources. In the present work the use of Lean manufacturing is to generate strategies to eliminate waste on the shop floor. The Lean manufacturing tools such as Kaizen were employed to reduce the waste. This paper describes a case study considering changeover time and reliability as a performance measures to improve the flow of production. Finally, the results obtained show the improvement in the shop floor region.*

Key words: *Lean manufacturing, Kaize, Waste, Changeover time, reliability*

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1. Introduction

In order to increase productivity of the company and reducing its waste lean manufacturing concept is applied. It reduces the input on every stage from getting a raw material, processing finished goods and making their delivery by less investment in tools and equipment, less working space, less workers, and less manufacturing time in process design (Womack, 1996). It is useful in the present date for the manufacturing company as it eliminates problems like overproduction, work in process inventory, transportation, rework and also many a times when delivery products revert back to the company due to defects and many other reasons. Thus Lean manufacturing concept results in satisfaction of both i.e. manufacturer and customer (Womack et al., 1990). Lean manufacturing techniques on the shop floor are often put up as the solution for manufacturers to compete in world markets (Drtina and Correa, 2011; Ott and Jones, 1999). Lean production is intended at the reduction of waste in every part of production including customer relations, product design, supplier networks, and factory management (KorbeKaare and Otto, 2014). It's objective is to incorporate less human effort, less inventory, less time to develop product, and less space to become highly responsive, to meet customer demand while producing top quality products in the most efficient and economical manners possible (Shah, 2007). Lean practices includes JIT, total quality management, total preventive maintenance, human resource management, low setup, controlled processes and productive maintenance.

Since global market mostly focuses on outsource or in-source production, it can rapidly and cost efficiently react to random changes in the business environment. Manzouri and Rahman (2013), put stress on the constancy as a major property of a supply chain which is critical for a constant relationship among customers and manufacturers.

2. Lean Manufacturing Tools

Lean manufacturing suggests many tools, which can assist in making the value to a customer in a simpler way. Some of the most broadly used tools are total productive maintenance (TPM), value stream mapping (VSM), JIT, 5 S, and Kaizen.

2.1 Total Productive Maintenance

TPM is a management philosophy that focuses on connecting all employees in a manufacturing organization in equipment improvement. It consists of different methods, which are known from maintenance management experience to be effective in improving reliability, quality, maintainability and production.

2.2 Value Stream Mapping

Value stream mapping is also known as VSM. It is one of the most successful tools of lean manufacturing. VSM mainly focuses the stream of the value and seeks to find the areas of improvement. VSM focuses on value in the framework of what the customer is willing to pay not for the wastes generated by the organization. The main objective of VSM is to find the lead-time associated with a certain product flow

throughout a system. The whole process of VSM can be divided into four key steps: (1) identify the family of products, (2) generate a current state value stream map, (3) suggests a future state value stream map, and (4) create an action plan.

2.3 *Just in time*

The aim of JIT is to keep the level of inventory to a smallest amount. This is achieved by permitting each operation to pull the objects from the precedential operation rather than pushing objects in the production system.

2.4 *5 S*

5 S is another useful tool of lean manufacturing, extensively used to maintain the working area neat, clean, and safe. The name 5 S generates from the first letter in the five Japanese words: Seiri, Seiton, Seison, Seiketsu, and Shitsuke. The Japanese words' meanings in English are sort, straighten, shine, standardize, and sustain. Usually, 5 S is implemented in bit by bit manner. In nutshell, all the objects lying at the work centre are differentiated as necessary and unnecessary objects. Thus, all this unnecessary objects are removed in a sorting phase. In the next phase, all the necessary items are arranged, and their position is defined. In a shine phase, the every area of the workplace is neatly cleaned, and the sources of contamination are identified. In the standardize phase, method is defined to maintain the improvement. In the sustain phase, the comprehensive program is developed to train people for good work practice.

2.5 *Kaizen*

Kaizen is one of the most popular terms used in the field of lean manufacturing. Kaizen means constant improvement. The surroundings is created at the work centre that enthusiasts people engaged in the day-to-day work to make the method of work more productive or better by continuously improving it (Pavnaskar et al., 2003).

3. Methodology

The methodology includes understanding the lean concepts, data collection, make a value stream map, propose future state map for the implementation of lean.

3.1 *Current Value Stream Map (CVSM)*

Data collection for the material flow started from despatch department, and worked backward all the way to the moulding process, gathering snapshot data such as inventory levels before each process, process cycle times (CTs), number of operators, and changeover (COT) times (Seth and Gupta, 2005; Abdulmalek, 2007; Singh et al., 2011). Figure1 shows the current state map that was constructed; the small boxes in the current value stream map represent the process and the number inside the box is the number of workers at each process. Also, each process has a data box below, which contains the process CT, the number of shifts, and the COT. It should be noted that this data was collected whilst walking the shop floor and discussion to the foreman, engineers, executives and operators at each workstation. The cycle time, demands are all based on the average of historical data.

Fig.1. Current Value Stream Map

After taking all the information and material flows, they are connected as indicated by arrows in the map, demonstrating how each workstation receives its schedule from material requirement planning department.

3.2 Future Value Stream Map (FVSM)

The following parameters should be considered while drawing the future value stream map or lean map (Ghosh, 2013; Mittal and Verma, 2016; Mohanraj et al., 2011).

-Production should be followed according to Tact time.

-Developing continuous flow wherever possible.

In future state map warehouse inventory is eliminated by sending the assembly directly to the trucks. Since U-50 air cleaner hourly requirement is 50 from each work station, a supermarket is installed to hold the inventory of 1 hour. Whenever customer requires air cleaner, its withdrawal Kanban will be given to the material handler (part feeder) to withdraw 1 hour equal of air cleaner from air assembly. When material handler removes 1-hour inventory from supermarket, a withdrawal Kanban will be sent back to the moulding machine (Figure2).

Fig. 2. Future Value Stream Map

4. Work- Plan and Implementation

To achieve FVSM cellular layout (manufacturing) has been proposed (Pattanaik, 2009; Sahoo et al., 2008; Rother and Shook, 1999). By virtue of which non-value lead-time can be reduced. To reduce changeover time either unnecessary activities are to be removed or sequence the activities according to the total time consume by the activities.

4.1. Changeover time

Changeover time is the time taken in changing one activity to another activity (Rakytá et al., 2016; Mulc et al., 2015; Daine et al., 2011; Irani, 1999). The time includes adding and removing the items.

For air cleaner assembly friction material different activities are required and to complete the assembly various tools (Items) are needed. These items are the direct or indirect parts of a machine. In the present case only direct parts are considered. Table 1 gives different activities and their items(assumed).

Activities	Items(I)
a_1^1	(c,d,e)
a_1^2	(e,g,h)
a_1^3	(c,d,g,f)

Tab.1. Activities and its Items

Table 2 gives the Changeover time in adding the Items from one activity to another.

Items\ Changeover time	a_1^{12}	a_1^{23}	a_1^{31}	a_1^{21}	a_1^{32}	a_1^{13}
C	-	1	-	1	-	-
D	-	3	-	1	-	-
E	-	-	4	-	2	-
F	-	4	-	-	-	4
G	6	-	-	-	-	4
H	6	-	-	-	6	-

Tab.2. Changeover Time (Sec) when adding the Items

$$NCAT = \alpha mc_{ij} + \beta mc_{pq} \quad (1)$$

α & β are the weights assigned ($\alpha + \beta = 1$) and i, j, p and q = 1, 2, 3 and the assumed value of α & β are 0.5. E.g. for Item c, $NCAT_c = \alpha mc_{23} + \beta mc_{21} = (1+1)/2 = 1$. Similarly Normalized Changeover addition time for different items can be calculated and listed in Table 4.

Table 3 gives the Changeover time in removing the items from one activity to another.

Items\ Changeover time	a_1^{12}	a_1^{23}	a_1^{31}	a_1^{21}	a_1^{32}	a_1^{13}
C	.5	-	-	-	.5	-
D	1	-	-	-	1	-
E	-	2	-	-	-	1
F	-	-	1	-	3	-
G	-	-	2	3	-	-
H	-	4	-	2	-	-

Tab.3. Changeover Time (Sec) when removing the Items

The Normalized Changeover removal time (NCRT) for different Items is given by

$$NCRT = \sigma mc_{ij} + \Omega mc_{pq} \quad (2)$$

where σ & Ω are the weights assigned ($\sigma + \Omega = 1$) and i, j, p and q = 1, 2, 3 and the assumed value of σ & Ω are 0.5. E.g. for Item c, $NCRT_c = \sigma mc_{12} + \Omega mc_{32} = 0.5$. Similarly, Normalized Changeover removal time for different items can be calculated and listed in Table 4.

Table 4 gives the normalized value of Changeover time in adding and removing the Items from one activity to another.

Items	Changeover time when adding the Items	Changeover time when removing the Items
C	1	.5
D	2	1
E	3	1.5
F	4	2
G	5	2.5
H	6	3

Tab.4. Changeovertime (Sec) for different Items (Normalized Value)

Total Changeover Time can be calculated as follows:

$$\text{TCT (Total ChangeoverTime)}_{ij} = \left(\mu \frac{\text{timeinaddingtheItems}}{\text{Totalavailabletime}} + \Omega \frac{\text{timeinremovingtheItems}}{\text{Totalavailabletime}} \right) \quad (3)$$

where $i, j=1, 2, 3$ and the assumed value of different weights are $\mu = 0.6$, $\Omega = 0.4$, and Total available time = 20 sec. The Items added are g and h and the Items removed are c and d in changing activity 1 to 2. Hence Total Changeover Time (TCT_{12}) = $0.5(5+6)/20 + 0.4(1.5)/20 = 0.4$. Similarly Total Changeover Time for TCT_{13} , TCT_{23} , TCT_{32} , TCT_{31} and TCT_{21} can be calculated and listed in table 5.

S.No.	Total Changeover time	Results
1	TCT_{12}	0.4
2	TCT_{13}	0.32
3	TCT_{23}	0.43
4	TCT_{32}	0.4
5	TCT_{31}	0.28
6	TCT_{21}	0.4

Tab.5. Total Changeover Time

The Cumulative Changeover-time for different activities are listed in Table 6.

S.N.	Sequence of activities	Total Changeover Time1	Total Changeover Time2	Cumulative Changeover Time
1	a_{123}	0.4	0.43	0.83
2	a_{132}	0.32	0.4	0.72
3	a_{213}	0.4	0.32	0.72
4	a_{231}	0.43	0.28	0.71
5	a_{312}	0.28	0.4	0.68
6	a_{321}	0.4	0.4	0.8

Tab. 6. Cumulative Changeover Time.

It has been found a_{312} is an optimum sequence of operations activity and will minimize the waste in terms of changeover time.

4.2 Reliability

Let us consider the sequence of activities (a_{312}) are having following configuration of items.

Where BS is the basic structure of configuration. The reliability of configuration is depending upon the reliabilities of basic structure and the reliabilities of items. Let us assume that reliabilities of basic structure and the auxiliary items e,g and h are 0.9,0.9,0.8 and 0.7 respectively. Reliability of the configuration (RC) = $R_{BS} \times R_{Auxiliary}$ activities:

$$RC = 0.9 \times 0.9 \times 0.8 \times 0.7 = 0.4536$$

4.3 Responsiveness Index (RI):

Responsiveness Index(RI) is defined as the weighted sum of changeover time and reliability of the configuration.

$$RI = \sigma (RC) + \lambda (CCT) \quad (4)$$

Where CCT is Cumulative Changeover Time of a_{312} . As changeover time is to minimize and reliability is to maximize for the configuration, σ should be larger than λ . Assume that $\sigma = 0.8$ and $\lambda = 0.2$.

From equation 4

$$RI = 0.8 \times RC + 0.2 \times CCT = 0.8 \times 0.4536 + 0.2 \times 0.68 = 0.3827$$

5. Conclusions

The in-tangible benefits obtained after implementation of lean tools are improved teamwork and communication, better flexibility and visibility improves safety, improves morale of the workers. It is the responsibility of the operations management and industrial engineering community to help organizations better understand kaizen events.

Operator training in skill development would improve competence and thus reduce worker setup and processing time for the machines/processes used in air cleaner assembly cell. The performance measures of the Lean manufacturing system give an indication to choose the activities in each stage. In the present study the performance parameter changeover time and reliability have been discussed. It has been found a_{312} is an optimum sequence of operations activity (least changeover time of 0.68) and will minimize the waste in terms of changeover time. This performance parameter is helpful

in minimizing the wastes. By minimizing the changeover time the lead time can be reduced and the system becomes more responsive. In future the authors plan to develop more performance parameter to the manufacturing system. The lean manufacturing concepts can be extended to other manufacturing areas of the plant such as assembly of seats etc. Besides that some software like ERP can also be used for reducing wastes.

6. References

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Abdulmalek, F.A . & Rajgopal, J. (2007). Analyzing the benefits of lean manufacturing and value stream mapping via simulation: a process sector case study. *International Journal of Production Economics*, Vol.107, No.1, pp. 223–236
- Daine, T.; Winnington, T. & Head, P. (2011). Transition from push to pull in the wholesale/retail sector: lessons to be learned from lean. *International Journal of Logistic Systems and Management*, Vol. 8, No. 2, pp. 214–232
- Drtina, R. & Correa, H.L. (2011). How transfer prices can affect a supply chain strategic decision. *International Journal of Logistic Systems and Management*, Vol. 8, No. 4, pp. 363–376
- Ghosh, M. (2013). Lean manufacturing performance in Indian manufacturing plants. *Journal of Manufacturing Technology Management*, Vol. 24, No. 1, pp. 113–122.
- Irani, S.A. (1999). *Handbook of Cellular Manufacturing Systems*, John Wiley & Sons, New York
- KörbeKaare, K.& Otto,T. (2014). Smart Health Care Monitoring Technologies to Improve Employee Performance in Manufacturing, *25th DAAAM International Symposium on Intelligent Manufacturing and Automation*, Vol. 100, pp. 826 – 833
- Manzouri, M. & Rahman, M. (2013). Adaptation of theories of supply chain management to the lean supply chain management. *Int. J. Logistics Systems and Management*, Vol. 14, No. 1, pp.38–54
- Mittal, K.K. & Verma, V. (2016). Lean manufacturing system for air cleaner assembly cell. *Int. J. Logistics Systems and Management*, Vol. 23, No. 3, pp. 314-328
- Mohanraj, R.; Sakthivel, M. & Vinodh, S. (2011). QFD integrated value stream mapping: an enabler of lean manufacturing. *International Journal of Productivity and Quality Management*, Vol. 7, No. 4, pp. 501–522
- Mulc, T.; Udiljak, T. & Ciglar, D. (2015). *Structure of Reconfigurable Manufacturing Systems*, DAAAM International Scientific Book 2015, ISBN 978-3-902734-05-1, ISSN 1726-9687, Vienna, Austria, pp. 369-390
- Ott ,S. & Jones, K. (1999). *Cellular Manufacturing. One-Piece Flow for Work teams*, CRC Press, BocaRaton
- Pavnaskar, S. J.; Gershenson, J. K. & Jambekar, A. B.(2003). Classification Scheme fo Lean Manufacturing Tools. *International Journal of Production Research*, Vol. 41, No. 13, pp. 3075–3090

- Pattanaik, L.N. & Sharma, B.P. (2009). Implementing lean manufacturing with cellular Layout. *International Journal of Advanced Manufacturing Technology*, Vol. 42, No. (7-8), pp. 772–779
- Rakytá, M.; Fusko, M.; Haluska, M. & Grznar, P. (2016). Maintenance Support System for Reconfigurable Manufacturing Systems, *Proceedings of the 26th DAAAM International Symposium*, ISBN 978-3-902734-07-5, ISSN 1726-9679, Vienna, Austria pp.1102-1108
- Rother, M. & Shook, J. (1999). *Learning to See: Value Stream Mapping to Add Value and Eliminate Muda*, The Lean Enterprise Institute, Inc., Brookline, MA
- Sahoo, A.K.; Singh, N. K. ; Shankar, R. & Tiwari, M. K. (2008). Lean Philosophy: Implementation in a Forging Company. *International Journal of Advanced Manufacturing Technology*, Vol. 36, No. 5–6, pp. 451–462
- Seth, D. & Gupta, V. (2005). Application of Value Stream Mapping for Lean Operations and Cycle Time Reduction: An Indian Case Study. *Production Planning & Control*, Vol. 16, No.1, pp. 44–59
- Shah, R. & Ward, P.T. (2007). Defining and developing measures of Lean production. *Journal of Operations Management*, Vol. 25, No.4, pp. 785–805
- Singh, B.; Garg, S.K. & Sharma, S.K. (2011). Value stream mapping: literature review and implication for Indian industry. *International Journal of Advanced Manufacturing Technology*, Vol. 53, No. 5-8, pp. 799–809
- Womack, J. P.; Jones, D.T. & Roos, D. (1990). *The Machine That Changed the World*, Macmillan Publishre, New York
- Womack, J.P. & Jones, D.T. (1996). *Lean thinking: banish waste and create wealth in your corporation*, Simon & Schuster, New York