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Research paper



Reducing the Production Lead Time of an Industry Using Value Stream Mapping Integrated with Kaizen

Ritesh Bhat[1]*, Nanjangud Mohan[2], Mohindar Naidu[3], Shivakumar Shivamurthy[4]

[1,2]Department of Mechanical and Manufacturing Engineering, Manipal Institute of Technology, Manipal Academy of Higher Education, Manipal, India, 567104
[3]Department of Mechanical Engineering, Manipal International University, Nilai, Malaysia, 71800
[4]Department of Mechanical Engineering, KLS Gogte Institute of Technology, Belgaum, Karnataka, India, 590008
**Corresponding author E-mail:ritesh.bhat@manipal.edu*

Abstract

Lean manufacturing tools and techniques acts as a major industrial management driver in the modern world since they attracted the industrialist at an early period in its raw form. Value stream mapping is a lean tool that helps not only to identify the issues hindering the productivity in an industry but also helps to decide upon the right lean tool to be used for improving the same. This article focuses on the implementation of value stream mapping in one of the leading pharmaceutical company to assess the current productivity and recommending improvement. The recommended improvement through the future state map shows that the effective implementation of lean tools reduces the production lead-time by 60.29%.

Keywords:*lean production, mapping; value stream mapping; industrial management; production lead-time;kaizen; work productivity*

1. Introduction

There exists no appropriate method of measuring productivity and thus for ease of understanding, the measurement is accomplished by classifying the term productivity as (WP) work productivity and (TFP) total factor productivity [1]. In the current scenario, the term work productivity, defined as the ratio of output in terms of sales to the input in terms of work hours, holds high importance. A small improvement in the productivity in terms of reduction in lead-time, optimization of changeover and cycle time, optimization of the required number of machine and operators, etc., changes the whole scenario in the positive direction for any industry [2].
Lean manufacturing tools and techniques acts as a major industrial management driver in the modern world, which helps in achieving the said changes in the firm [2]. Mapping the whole chain of production is the first step in any lean concept implementation and the value stream mapping (VSM) justifies being the right tool to be used for this purpose. The usage of VSM has helped several firms to identify the loopholes in their complete production chain and has been capable of recommending the required changes at the right places [3]–[5].
VSM for its popularity is not only finding its application in the core mechanical engineering but also in various other firms, one of them being the pharmaceutical companies. VSM has proven to be an enhancement tool for communication and collaboration in all the firms [6].
VSM just like any other tool of lean manufacturing follows steps for its implementation. The first step is always to identify the right product (heavily demanded) followed by determining its process line and customer demand. The data from procurement to supply, for each inter-staged workstations is noted. The data recorded supports in drawing the current state map, constructed for the detailed analyzing purpose. This stage not only identifies the findings related to loopholes hindering the work productivity but also focuses on the implementation of the right secondary lean tools like Kanban, line balancing, etc., to get over the loopholes.
Based on the improvement, the future state map is drawn, giving recommendation for implementation [2], [7]. The objective of this study is to evaluate how VSM helps to improve the work productivity in a pharmaceutical firm's production line by reducing the production lead-time of the critical product.

2. Method

A case study as ABC Pvt. Ltd. is considered, producing the drug, ALPHA1 is focused, which is one of the major selling certified drugs in the market in form of cartridges. The average monthly production of the company is 92,000 units and the monthly working day is 22. Once raw material arrives to the firm, the operators unpack the cartons of components and sends for dispensing the components followed by formulation stage. Then the ALPHA1 moves through sample analysis stage followed by the washing and filtration stage, which marks to be the longest process. ALPHA1 then moves to the filling stage followed by sealing stage. The sealed drug undergoes visual inspection, after which, it is packed and shipped.The methodology of implementing VSM in ABC Pvt. Ltd. process line of ALPHA1 is as shown in Fig. 1.

The evaluation implements Kaizen in terms of its 3G's viz., Gemba (information from shop floor), Gembutsu (information of the selected product) and Genjitsu (information from facts) to gather the relevant data at the ABC Pvt. Ltd. process line of ALPHA1 for six months. Gemba conducted to investigate the shop-floor process line flow and standard production procedure of ALPHA1, preceded the setting up the data collection. It then followed

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conducting production lead-time study to collect and measure the relevant value stream (VS) information i.e. Gembutsu.
The measurements include the processing time (c/t), changeover time (c/o), uptime, available time and operator numbers in each stage to establish the baseline for data examination. Recorded and quantified information from facts i.e. Genjitsu through Line observation helped to construct the current state map.



Fig. 1: Methodology of VSM implementation in ABC Pvt. Ltd. for ALPHA1 process line

The construction of current state map (CSM) is based on recognizing the flow of materials and information in the actual ABC Pvt. Ltd process line for ALPHA1, and transferring the composed data; (lead time, processing time, and changeover time), inventories, work-in-progress materials, customer demand, and supplier information into CSM using the specific graphic symbols. This step helped to identify the bottleneck of ABC Pvt. Ltd process line for ALPHA1. CSM analysis resulted in identifying the improvement opportunities.
Future state map (FSM) designed, provided guidelines for improvement activities. The FSM includes crucial actions that would continuously improve the ABC Pvt. Ltd process line for ALPHA1 by developing the lean flow comprising kaizen (small changes to achieve big improvements) activities. All the actions focused on improving the entire process by reducing muda (waste), mura (over-burden) and muri (un-evenness). (The map drawn are not included in the paper due the non-disclosure policy)

3. Results and Discussion

3.1. Current state map results

Table 1 and Table 2 in the article represents the overall summary of the measurements at ABC Pvt. Ltd process line for ALPHA1 as per the current state map.
The results clearly depict that the processing time for washing and filtration, inspection and packaging process is beyond the calculated takt time. The total lead-time with the current state map is 68 days for 17,000 products (customer demand per month). The total value adding processing time is 372 seconds. In addition, the processing time for the dispensing, formulation and sample analysis is excessively lesser than the calculated takt time.

Table 1: Time measurement through CSM

Process Name	Dispensing	Formulation	Sample Analysis	Washing and Filtration
No. of Operators	3	4	2	6
Processing Time, c/t (sec.)	11	11	4	43
Average Changeover/day	0	1	1	1
Changeover time, c/o (sec.)	0	29	0	18
Effective Processing Time (sec.)	11	11	4	43
Batch size	1000	1000	1000	1000
Work-in-process inventory	0	900	0	0
Available time (sec.)	23,900	23,900	23,900	23,900
Uptime	100.00%	99.88%	100.00%	99.92%

Table 2: Time measurement through CSM

Process Name	Filling	Sealing	Inspection	Packaging
No. of Operators	4	1	8	8
Processing Time, c/t (sec.)	22	22	173	86
Average Changeover/day	1	1	0	0
Changeover time, c/o (sec.)	3.6	0	0	0
Effective Processing Time (sec.)	22	22	173	86
Batch size	1000	1000	1000	1000
Work-in-process inventory	0	0	600	600
Available time (sec.)	23,900	23,900	23,900	23,900
Uptime	99.98%	100.00%	100.00%	100.00%

The TAKT time for the ABC Pvt. Ltd process line for ALPHA1 is given as 23,900/773 = 30.91 seconds.

3.2. Future state map results

The recommendation given to the firm for improving the work productivity by reducing the lead-time are:

- Merge dispensing, formulation and sample analysis processes.
- Merge inspection and packing processes.
- Either recruit 118 personnel to compensate the lead-time or go for automation in last process.
- Except dispensing, formulation and sample analysis process, all other must operate for two shifts.

Table 3 and Table 4 represents the time measurement based on the conceptual future state map.

Table 3: Time measurement based on conceptual future state map

Process Name	*Dispensing, Formulation & Sample Analysis*	*Washing and Filtration*	*Filling*
No. of Operators	6	6	8
Processing Time, P/T (sec)	28	22	22
Average Changeover/day	0	2	1
Changeover time, C/O (sec.)	0	9	1.8
Effective Processing Time (sec.)	28	22	22
Batch size	2000	2000	2000
Work-in-process inventory	0	0	0
Available time (sec.)	23,900	47,800	47,800
Uptime	100.00%	99.98%	100.00%

Table 4: Time measurement based on conceptual future state map

Process Name	Sealing	Inspection & Packaging
No. of Operators	2	132
Processing Time, P/T (sec)	22	31
Average Changeover/day	1	0
Changeover time, C/O (sec.)	0	0
Effective Processing Time (sec.)	22	31
Batch size	2000	2000
Work-in-process	0	0

inventory		
Available time (sec.)	47,800	47,800
Uptime	100.00%	100.00%

From the conceptual future state map, the new production lead-time for 17,000 product is 27 days and the value adding processing time 125 seconds.

4. Conclusion

The conceptual future state map once implemented assures to provide the firm, a reduction of lead-time by 60.29 % along with an appreciable amount of reduction in the processing time. The recommendation though incurs the cost of additional work force /automation, but is worth spending for once.

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