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Productivity Improvement through Theory of Constraint Technique: A Case Study in Medium Scale Manufacturing Plant

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Abstract - Production lines are flow-line production systems which are of great importance in the industrial production of high quantity standardized commodities and more recently even gained importance in low volume production of customized products. In Small Medium Enterprise (SME) manufacturing plant, production line gives high impact to the productivity of the company. Less of skill and knowledge in management in the company make the SME cannot compete to large company. This case study is important to SME Company to solve the problem. The main objective of this project is to improve the productivity of the specific production line in the medium scale industry. In this paper described, Theory of Constraint technique is used to improve productivity of particular product manufacturing on production line.

Keywords- TOC, SME, Productivity Improvement.

1. INTRODUCTION

Today many of small medium enterprise were developing because of the encouragement from the government and the awareness from the society. Many of the small medium enterprise have a lack of knowledge to manage the company especially in arrangement of the workers or machine in the production line or company. Consequently, maximum production cannot be archived. Due to the global competition, management issues such as reduced cycle time, increased quality, reduced costs, reduced inventory and increasing sales and market share, have become more important to survive. Theory of Constraint is one of technique for productivity improvement by improving manufacturing system performance [4]. The Theory of Constraints (TOC) is a way to look at business processes to make them more productive according to their goals. Goldratt (1984) first developed this management philosophy in the eighties. TOC tries to identify constraints in the system, and exploit and elevate them to improve the overall output of the system [2].

2. CONCEPT OF THEORY OF CONSTRAINTS

Dr. Eliyahu Goldratt introduced the concept of Theory of Constraints (TOC) to improve the performance and procedure for the implementing DBR. The five Focusing steps of TOC provide a simple and effective approach to continuous improvement in cases where the constraint is fairly clearly identifiable.

Step 1: Identify the systems constraint or bottleneck.

Identify the operation that is limiting the productivity of the system. This may be a physical or policy constraint.

Step 2: Decide how to exploit the bottlenecks.

Achieve the best possible output from the constraint. Remove limitations that constrain the flow and reduce non-productive time, so that the constraint is used in the most effective way possible.

Step 3: Subordinate everything else to the above decision.
Link the output of other operations to suit the constraint. Smooth work flow and avoid build-up of work-in-process inventory. Avoid making the constraint wait for operation.

Step 4: Elevate the system's bottlenecks.
In situations where the system constraint still does not have sufficient output invest in new equipment or increase staff numbers to increase output.

Step 5: If in a previous step a bottleneck has been broken go back to step 1.
Assess to see if another operation or policy has become the system constraint.

3. CASE STUDY

From previous data analysis of the company, it found that the selected component for the study has maximum demand from customer. Also during manufacturing of the selected housing part,company was facing bottlenecks in the production line. These bottlenecks causes reduce the rate of production. Hence company fail to reach required production demand. The requirement of the company is to achieve the demand placed from customer. Layout of housing production line showsfigure 1.

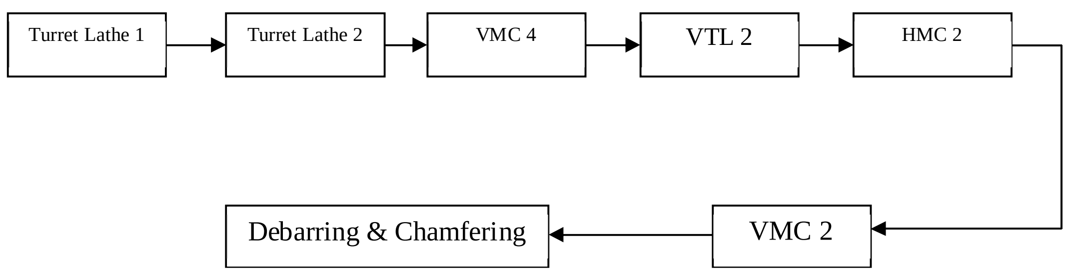

Fig. 1: Layout of Housing Production Line before Implementation

The major problems of company facing during manufacturing of selected housing product are,

1. Problems associated with dispatches.
2. Problems associated with Work-in-process inventory.
3. Problems associated with Raw material inventory.

The available capacity and demand placed on each resource was carried out using time study method. The comparison between available capacity and the required capacity (demand) is very useful to identification of constraint resource (CR). The resource having capacity less than demand is identified constraint resource (CR). The resource having available capacity more than required capacity (demand) is identified as non-constraint resource (NCR). When the available capacity matches with demand those resources are identified as capacity constraint resource (CCR).

Table 1:Comparison between available capacity and demand for resources

Sr no.	Machine resource	Available capacity (minutes)	Demand per day (minutes)	Remark
1	Turret Lathe 1	1230 min	1080 min	NCR
2	Turret Lathe 2	1230 min	1080 min	NCR

3	VMC 4	1230 min	1200 min	NCR
4	VTL 2	1230 min	1380 min	CR
5	HMC 2	1230 min	1500 min	CR
6	VMC 1	1230 min	960 min	NCR
7	Chamfering and Debarring	1230 min	540 min	NCR

Table 1 indicates that available capacity of resources for Turret Lathe 1, Turret Lathe 2, VMC 4, Chamfering and Debarring is more than demand hence these resources are identified as non-constraint resources (NCR). But available capacity of resources VTL 2 and HMC 2 is less than required capacity (demand), hence VTL 2 and HMC 2 are identified as constraint resources (CR).

Analysis of WIP inventory of selected housing product manufacturing on housing production line was carried out; and observed that WIP inventory associated with HMC 2 machine and VTL 2 machine is huge amount.

Decision regarding buffer stock (capacity buffer)

According to TOC methodology, buffer stock should be maintaining in front of constraint resources. The figure1 shows layout of housing production line. In this production line there are two constraint resources identified i.e. HMC 2 machine and VTL 2 machine, because limited capacity with respect to demand placed on these resources.

Solved HMC 2 constraint resource

Available capacity of the each resource in the selected production line is 1230 minutes per day (3 shifts). The demand of HMC 2 machine is 1500 minutes are available per day. This means that capacity of HMC 2 machine is less than demand placed on it and maximum amount of WIP inventory accumulated in front of HMC 2 machine. Hence HMC 2 machine is identified as constraint resource. For achieving the production target 40 parts are required from each resource in selected housing production line per shift, but because of limited capacity HMC 2 machine it produced about 32 parts per shift. Hence there is shortage of about 8 parts per shift.
HMC 2 machine utilized side milling, side drilling, tapping and countering operations on selected housing product. For these operations, cycle time required on HMC 2 machine is 12.5 minutes. To overcome this problem we introduce tap fast (TM L1) machine. To shift tapping and chamfering operations of HMC 2 on tap fast 1 machine. Therefore HMC 2 machine is utilised only for side milling and side drilling operations.

Solved VTL 2 constraint resource

After HMC 2 machine is converted constraint resource (CR) into capacity constraint resource (CCR), the performance of housing production line was carried out. After performance of housing production line measured by introducing tap fast 1 machine, it is found that, VTL 2 machine was constraint resource because it's capacity less than demand. Also in front of VTL 2 machine huge WIP inventory accumulated.

The capacity of the each resource in housing production line is 1230 minutes for 3 per day. The demand of VTL 2 machine is 1380 minutes per day. This means that, capacity of VTL 2 machine less than demand placed on it. In front of VTL 2 machine 5 parts WIP inventory accumulated per shift; hence it is identified as constraint resource.

The buffer stock should be maintained in front of the constraint resource so as to avoid any disruption in the flow. For achieving the production target 40 parts are required from each resource in selected housing production line per shift. But because of limited capacity VTL 2 machine it produced 34 to 35 parts. Hence there was shortage of 5 parts per shift.

To overcome this problem, by introducing turret lathe 3 (TL3) machine. (TL 3) machine is maintained 5 housing parts capacity buffer stock in front of the VTL 2 machine and balance the production line. Total cycle time of (TL 3) machine is 16 minutes per job. After involving (TL3) resource, it is provided 5 parts per shift and line is balance. Each shift TL3 utilise up to 80 to 90 minutes. Remaining 320 minutes TL3 utilise for machining of other housing products and development work.

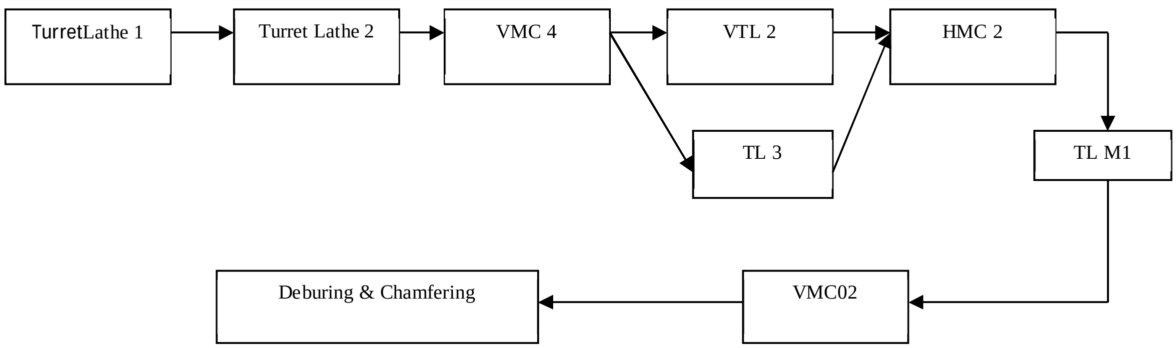

Fig. 2: Layout of Housing Production Line after Implementation

After involving buffer stock in front of the constraint resources the selected housing line is balanced and production of each shift is achieved. Layout of housing production line after implementation of TOC is shown in figure 2.

4. RESULTS AND DISCUSSION

To examine the impact of Theory of Constraint technique, performance measurement system is developed. After that, physical measurement of all performance measurement parameters is carried out before and after implementation of TOC. The period from July 2015 to November 2015 represent pre-implementation period and post implementation period from December 2015 to April 2016.

4.1 Effect of TOC Methodology on Average WIP Inventory

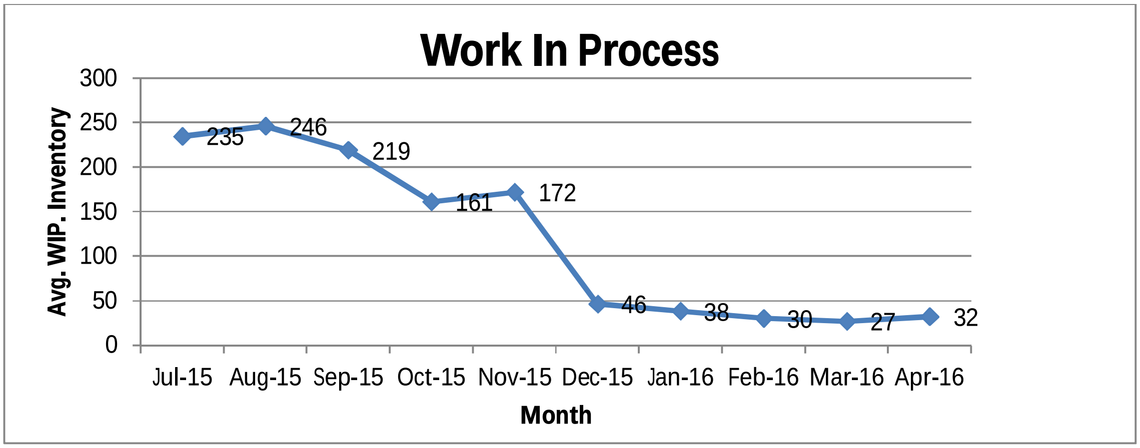

Fig. 3: Average Amount of WIP

Average amount of reduction of WIP inventory due to the implementation of TOC for selected housing product is graphically represented shown in fig.3. The average amount of WIP inventory before implementation was 207 housings. This reduced to 35 housings per month after implementation of TOC.

4.2 Average Percentage of On Time Deliveries before & after TOC.

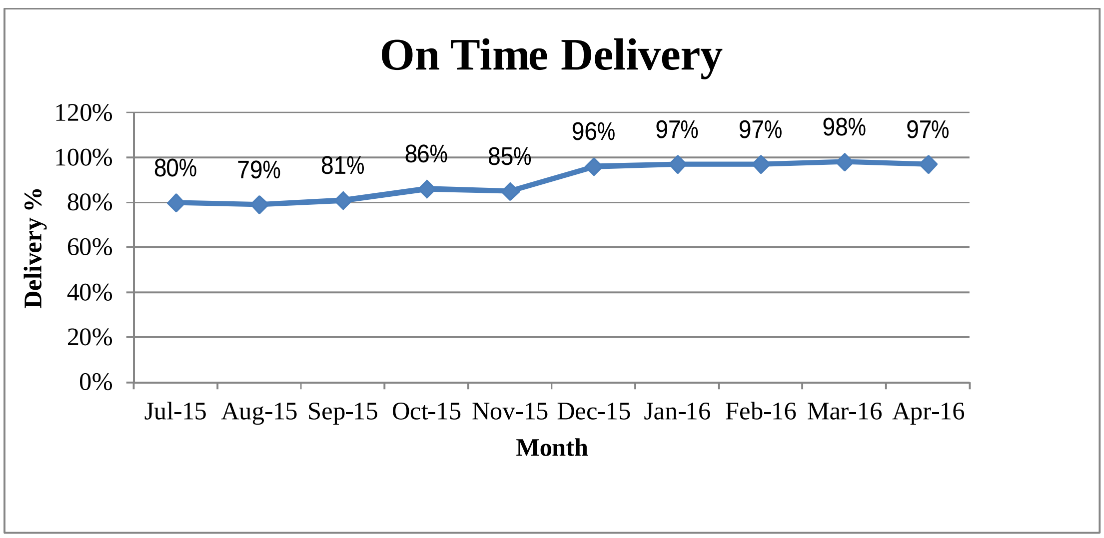

Fig. 4: Percentage of On Time Deliveries

The average amount of on time delivers before implementation was 82%. This improves 97% after implementation i.e. 15% increment in on time deliveries after implementation of TOC. This consequently resulted in improved throughput.

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4.3 Effect of TOC Implementation, on Raw Material Inventory (RMI)

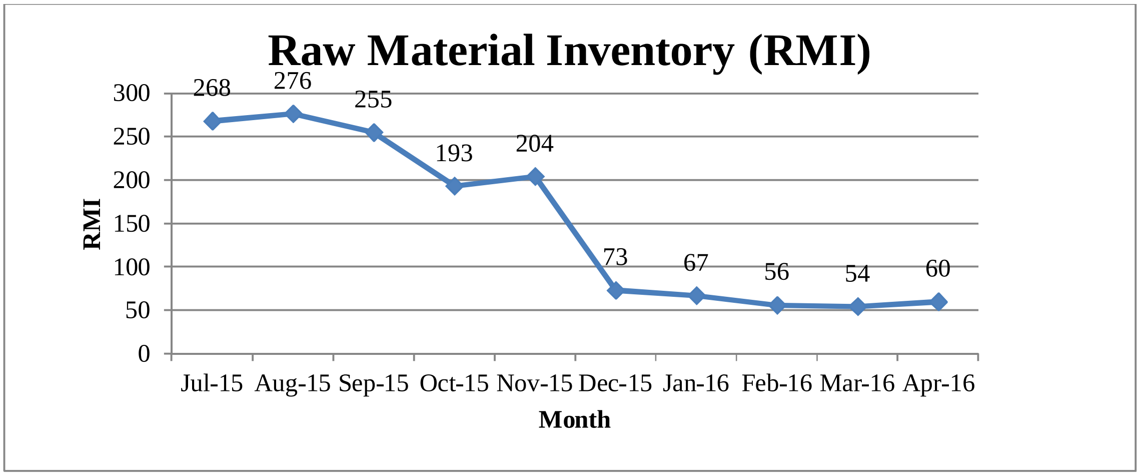

Fig. 5: Amount of Raw Material inventory

Average amount of reduction of raw material inventory due to the implementation of TOC for selected housing product is graphically represented shown in fig.5. The average amount of raw material inventory before implementation was 239 housings. This reduced to 62 after implementation.

5. CONCLUSION

TOC brings a new dimension to management philosophy and provides an interesting challenge to the traditional ways of looking at an organization's profitability. Adopted within a wide variety of organizations and settings, it appears that organizations using theory of constraint (TOC) have determined that it can help them achieve a number ofmanagement objectives, including continuous improvement.

Following benefits are obtained by implementation of TOC.

1. The demand achieved for selected housing product increased from 82% to 97% after implementation of TOC, resulting in improvement of 15% on time delivery.
2. The average amount of work in process inventory for selected housing product is reduced. Before implementation of theory of constraint WIP was 207 and it is reduced up to 35 housings after implementation. This gives 83% reduction in work in process inventory of selected housing product.
3. The average amount of raw material inventory for selected housing product is reduced. Before implementation of theory of constraint raw material inventory was 239 housings and it is reduced up to 62 housings after implementation. This gives 74% reduction in raw material inventory of selected housing product.
4. Implementation of TOC results in reducing the WIP and raw material inventory; hence space availability in the store as well as production shop is increased. It also improves the quality of product due to better control over operation of constraint resources. The idle time of non-constraint resources are utilized by other purposes e.g. developments work.

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