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# Implementation of Manufacturing Excellence in an Indian Manufacturing Industry

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***Abstract:*** ***Industries today are working towards decentralizing their structure to get near to the customer to know the actual demand of customer in order to reduce lead times and trying to become more flexible in order to fulfill the customer's demand and improve the level of satisfaction. They had also implemented various improvement methodologies like lean and, Six Sigma etc. to achieve the goals. The work in this paper is a study performed at Cummins Turbo Technologies, Dewas. Turbo Plant focuses on achieving Manufacturing functional excellence under Operation Excellence Project.***
***Keywords: Operation Excellence, Manufacturing Excellence (MEFE), TAKT time, Line Balancing, SMED, Setup reduction, Standard working methods.***

## I. INTRODUCTION

Operational excellence is considered as a competitive approach for organizations, both in manufacturing and in service. Organizations should, therefore, need to carefully study their operation strategy practices because of the high impact that results from applying operation strategy decisions on operational excellence. There are many factors important to achieving operational excellence. When all functions of the organization i.e. Human resource, Finance, Operations, sourcing etc. directly or indirectly affects operation excellence strategy. Although the concept of operational excellence is quite new the idea behind it has evolved over time into what we know today. The contributions, innovations and efforts of many people set the grounds for excellence. With the beginning industrial era there are continuous attempts to improve and create better processes and systems, to reduce the work of men, to make production and service more effective with higher revenues and lower costs.
Key Practices of OE for manufacturing system

### *A. Takt Time and Line Balancing*

Goal - To reliably produce at a rate which match customer demand.
Rationale- Producing at either above or below the customer demand generates waste in the form of inventory both over production and under production results in cost so it is important to match pace with the demand of customer. As a stable system will result in improved efficiency, optimized workforce and reduced operating hours.

### *B. Bottle Neck Management*

Goal - To identify, Understand, Manage and Improve operational constraints that limit output or production capacity of a process.
Rationale- Every process or value stream has a bottleneck and by managing the bottleneck operation to maximizing the throughput will lead to effectiveness of the whole process. Implementation of Manufacturing Excellence (MEFE) at Cummins Turbo Technologies, Dewas

### *C. Setup Reduction*

Goal - To enable one-piece flow by minimizing or completely eliminating the time which is lost in a line or a cell due to changeovers.
Rationale- Reduced setup time is fundamental to just in time production and one-piece flow, shorter setup time enable more frequent changeovers, smaller lot size and lower inventories of both finished goods and work in progress material/components which eventually will improve responsiveness to customer needs this can lead to decreased lot sizes improves alignment with customer Takt times and decreased floor space requirements.

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*D. Standard Working Methods*

Goal- Standard working methods describe the best currently known work sequence with clearly defined process methods and elemental times of all task that are consistently and repeatedly carried out.

Rationale- Standard working methods are used to eliminate variation in our process caused by inconsistent working methods. Standard working methods are necessary to have a validated starting point for the continuous improvement. Standard working methods are used to make normal state obvious and auditable which can help us to identify variation and can be eliminated they also provide baseline for kaizen and six sigma projects.

## II. LITERATURE REVIEW

*A. Operation Excellence*

The word excellence stands for ―quality and perfection‖ it is one thing which every industry around the world is seeking for and Operation Excellence is a tool to achieve both. Operation Excellence is management of all aspects of organization which includes every function like Quality, Manufacturing, Operations, Finance, SCM, HR etc. to achieve superior outcome across all functions of organization. (Dennis P. Nolan, 2015) The increase in global competition and the need to reduce cost of operations during difficult economic climates have become the main drivers for organizations to introduce continuous improvement and eliminate non-value adding operations. Operational Excellence is not about eliminating muda. It‘s about setting up an operation that will enable perpetual business growth. And by following a step-by-step methodology and implementing a design for business operations, a company can achieve Operational Excellence and thrive in a short amount of time. Many organizations in recent times have become too reliant on the concepts and tools of Lean Manufacturing, Total Quality Management and Six-Sigma such as Kaizen and Overall Equipment Effectiveness. While these concepts and tools have helped to improve processes and reduce cost, they have under delivered in terms of cost savings and process efficiency, a problem which has been attributed to the programmatic tool oriented deployment of these concepts (Rusev et. al. 2016).

Gemba conducted to study the production process flow and standard operation procedures which was selected before setting up the data collection, Gemba means the real place in company where things, problems, abnormalities happen - for example where products are developed or made or where services are provided, etc. It then followed by conducting time study to collect and measure the relevant value stream data i.e. Gembutsu, Gembutsu means the real tangible objects/things in Gemba like machines, equipment, tools, etc. (D. Dysco, 2008) The measurements include the cycle time, processing time, changeover time, transportation time, queuing, handling time to establish the baseline for data analysis. Line observation Genjitsu is captured and quantified to identify the current value stream.

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Table 1. The 3G’s

| | | |
|---|---|---|
| Gemba | Real place | Go to the place where it happens |
| Gembutsu | Real things | Examine machine, tools, material, objects |
| Genjitsu | Real facts | Check the facts phenomenon and mechanism |

(Maskell B, 2001) The use of value stream mapping to the field of accounting to determine the process costs of a value stream was extended. The information contained in value stream maps can be used to calculate current and future state process costs and create value stream profit-and-loss statements.

*B. Setup Reduction or SMED*

Lean Manufacturing is considered to be a waste reduction technique as suggested by many authors, but in practice lean manufacturing maximizes the value of the product through the minimization of waste indicated three main reasons why set-up reduction initiatives can be appropriate for any company: to increase flexibility by conducting more changeovers and reducing lot size; to increase bottleneck capacities in order to maximize the line availability for production; and to minimize the cost, since production costs are related to equipment effectiveness.(Sabadka et. Al, 2017), According to (Chirani A., 2014) the most important

LM tools to eliminate the different kinds of waste in production are value stream map, cellular manufacturing, total productive maintenance and single minutes Exchange of dies (SMED). (Berna Uluts, 2011) in his papers explained that SMED (Single Minuit Exchange of Dies) is one of the many lean production methods for reducing waste in a manufacturing process. It provides a rapid and efficient way of converting a manufacturing process from running the current product to running the next product.

Abraham and kailash Motwani (2012) indicated that a setup time reduction in the bottleneck BMS machine can be accomplished by applying SMED to stamping production line. Setup time of bottleneck machine was reduced by 75%, leading to a great improvement in the productivity.

Kumar and Abuthakeer (2012) reduced the setup time in an automobile industry and demonstrated that the productivity can be enhancement by SMED implementation. The SMED method can be implemented in most of the industries, but it has been applied to manufacturing process, administration services, and assembly operations.

McIntosh, Owen, Culley, and Mileham (2007) have proposed that the potential improvements in the changeover time can be done either by changing the sequence of activities without any variation in the way of performing tasks or by altering the existing activities to complete the task more rapidly. Most of the authors and researchers conveyed the benefits and saving by eliminating or reducing wastefulness and non-value added value tasks and activities using SMED method.

## III. RESEARCH METHODOLOGY

The key practices mentioned above might seems different but have an interrelationship between them by which they can be managed at a same time by various cross functional teams. And can be easily tracked and identified on value stream map. To manage multiple key processes following methodology is proposed-

*1)* Step 1- Prepare and Defined standard work for the system so each and every individual in every shift can do the job by a standard defined procedure, which will create a point to improve process if required.

*2)* Step 2- conduct the Gemba to study the production process flow and standard operation procedures which was selected before setting up the data collection.

*3)* Step 3- It then followed by conducting time study to collect and measure the relevant value stream data i.e. Gembutsu. The measurements include the cycle time, processing time, changeover time, transportation time, queuing, handling time to establish the baseline for data analysis.

*4)* Step 4- The projects identified are classified into line balancing projects which can be done by using techniques like Yamazumi or MOST, the projects for SMED can be done by using SMED technique, by doing continuous kaizen or improving batch size or proper planning can be done for Bottleneck Management Projects.

*5)* Step 5- Once the improvements are done create the control plans, train the associates to new working method‘s.

## IV. DATA ANALYSIS

### *A. Optimization of Motion by MOST*

Is heaving high cycle time of more than 67 seconds and to reduce it every activity is broken down to elemental level and studied on the basis of MOST i.e. Basic MOST by using:

General move (ABG ABP A)

Controlled move (ABG MXI A)

Tool use move (ABG ABP T ABP A).

Each activity is mapped based on the sequences mentioned above and allotted an index value based on the nature of motion, then the index values are added together and multiplied by 10 to get the values in TMU After finding out TMU‘s it is multiplied by 0.036 which will convert TMU to seconds

After mapping the sequence, the activities with higher index values are identified and improvements are done to convert higher index values to the lower index values.

Comparing both table the earlier station an associate takes 1950 TMU‘s to perform his task i.e. (1950*0.036) 70 seconds, where after improvements TMU is reduced to 1730 TMU‘s i.e. (1730*0.036) 62 seconds with an improvement of 8 seconds in cycle time of station.

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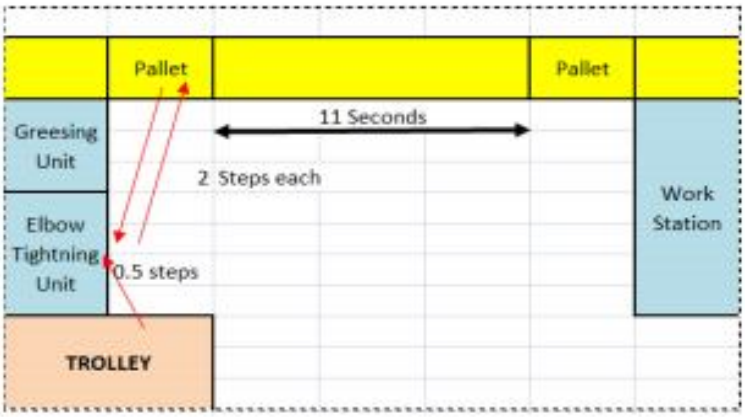



Figure 1. Station layout before MOST




Figure 2. Improvement in station layout after MOST

*B. Setup Changeover Reduction*

Based on the VSM of Impeller Cell it is identified that the changeover time at the impeller m/c 10A is high and changeovers are frequent which was affecting the flexibility of cell and resulting in downtimes for that setup changeover time reduction is required, for that SMED approach is used.

1) *Define:* To reduce setup changeover time in impeller 10 A because of increasing demand and because of high setup changeover time it was not important to achieve demand.
2) *Measure:* Observe the whole process of setup changeover, then breakdown each activity and classify activities as internal and external element.
3) *Analyze:* The changeover activities are analyzed and following outputs were obtained-

*a)* The help of Pareto chart we identified that the tool changeover activity consumes 1/3rd of the time in setup changeover.
*b)* It was found that a skilled associated took less time to setup changeover as compared to a new associate, so training of associates was considering another parameter for reducing changeover time.
*c)* Availability of proper tools and equipment is also need to be ensured nearer to station so time required to find tools and equipment can be reduced.

4) *Improve:* SMED approach focuses on converting internal elements to external elements and by Pareto analysis it was found that tool change time and probing time is very high, after that improvements initiated on the turret it was found out that turret was not effectively utilized and more tools can be mounted on the turret thus by making the internal elements into the external elements which will eliminate the tool change and probing time.
5) *Control:* After completion of the project the associates are trained and training is mapped on training matrix and the process is documented on SOP‘s and placed near the m/c so any associate can go through it and can identify any further improvements in the process.

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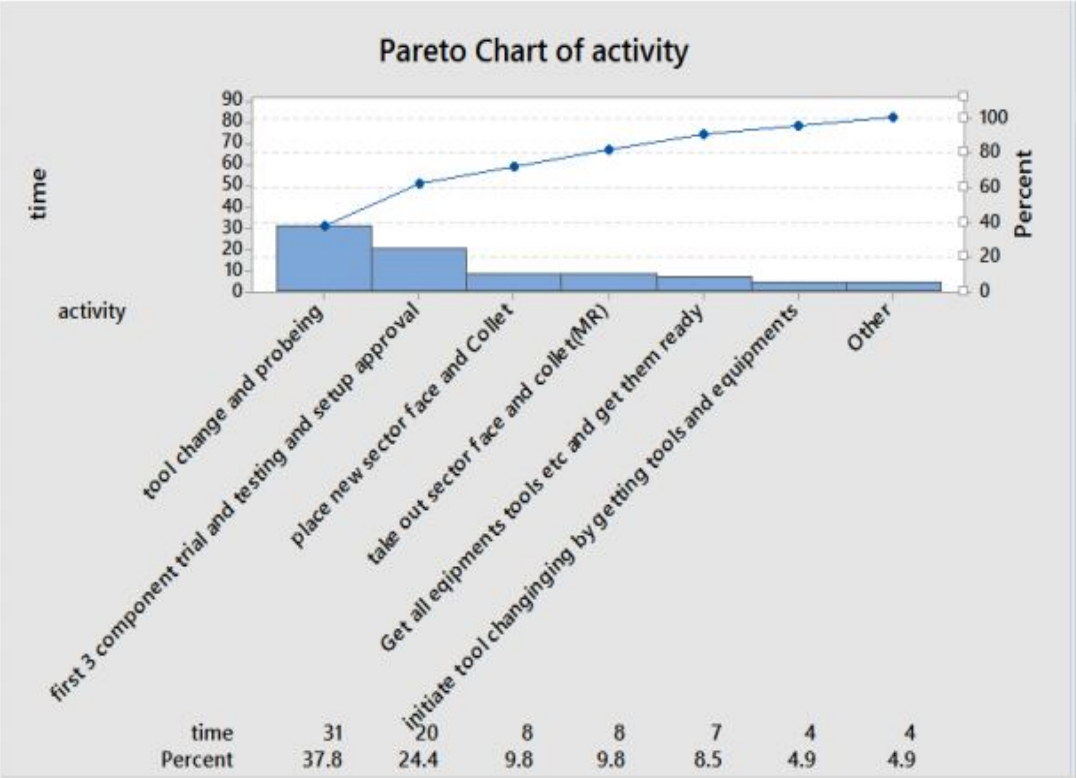



Figure 3. Pareto Analysis of Changeover activity

Table 2. Turret setup before and after improvement

| Tool Post No. | Before | After |
|---|---|---|
| T1 | Empty | Drill |
| T2 | Empty | Empty |
| T3 | Drill | Remer E6 |
| T4 | Empty | Empty |
| T5 | Remer (E6 or MR) | Remer MR |
| T6 | Empty | Empty |
| T7 | Roller Burnisher (E6 or MR) | Roller Burnisher MR |
| T8 | Empty | Empty |
| T9 | Boring Bar | Roller Burnisher E6 |
| T10 | Finishing | Finishing |
| T11 | Centre Drill | Centre Drill |
| T12 | Roughing | Roughing |

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Table 3. Setup Changeover time after improvement

| S. no. | Task | Time | Unit | I/E |
|---|---|---|---|---|
| 1. | Get all equipment tools etc. and get them ready | 2 | Min | E |
| 2 | take out sector face and collet(MR) | 8 | Min | I |
| 3. | place new sector face and Collet | 8 | Min | I |
| 4. | initiate tool changing by getting tools and equipment | 0 | Min | E |
| 5. | change roller Burnisher | 0 | Min | E |
| 6. | change reamer | 0 | Min | E |
| 7. | change drill | 5 | Min | I |
| 8. | select program for probing | 2 | Min | E |
| 9. | probing for drill | 0 | Min | E |
| 10. | probing for reamer | 0 | Min | E |
| 11. | Probing for burnisher | 0 | Min | E |
| 12. | Probing for burnisher | 0 | Min | E |
| 13. | sector face cutting | 4 | Min | I |
| 14. | first 3 component trial and testing and setup approval | 20 | Min | E |
| Total Time | | 49 | Min | |

## V. CONCLUSION

### *A. Line Balancing Projects*

The project was carried out in the MR-2 assembly line and in impeller cell The result shows significant increase in productivity and reduction in non-value added work in both of cells under study

MR-2 Assembly line- The goal was to improve the capacity of line from 300 per shift to 375 per shift to match the TAKT because of increase in the customer‘s demand. For that projects on 3 stations with highest cycle times were initiated and by using appropriate lean tools the cycle times were brought under Takt time.

Table 4. MR 2 Current state Vs Future State VSM

| CURRENT STATE | | | FUTURE STATE | | |
|---|---|---|---|---|---|
| Net Available Time | 400 | min | Net Available Time | 400 | min |
| Total Shift in month | 48 | no‘s | Total Shift in month | 48 | no‘s |
| Shift in day | 2 | no‘s | Shift in day | 2 | no‘s |
| Demand | 300 | per shift | Demand | 375 | per shift |
| TAKT TIME | 80 | Sec | TAKT TIME | 64 | Sec |
| target cycle time | 72 | Sec | target cycle time | 58 | Sec |

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*B. Setup Changeover Project*

Based on VSM of impeller it was targeted to reduce Changeover time of Impeller 10 A m/c which was 85- 90 min and sometimes exceed this range b/c of the skill of the worker with high frequency of setup change on the machine to Reduce it an SMED project was initiated and an improvement of 41 % in c/o time is achieved.

The lean tools and techniques are now well defined & accepted at different levels in the Industry. Lean manufacturing techniques are recognized as an effective way to improve the performance and production in manufacturing companies. The key element for the success of lean implementation is good understanding and acceptance by the industry‘s personnel‘s. There are several tools in lean manufacturing. Some of them are SMED, Kaizen, Kanban, VSM, Bottleneck Management etc. Different techniques can be applied concurrently to improve the production processes and management at various level of industry.

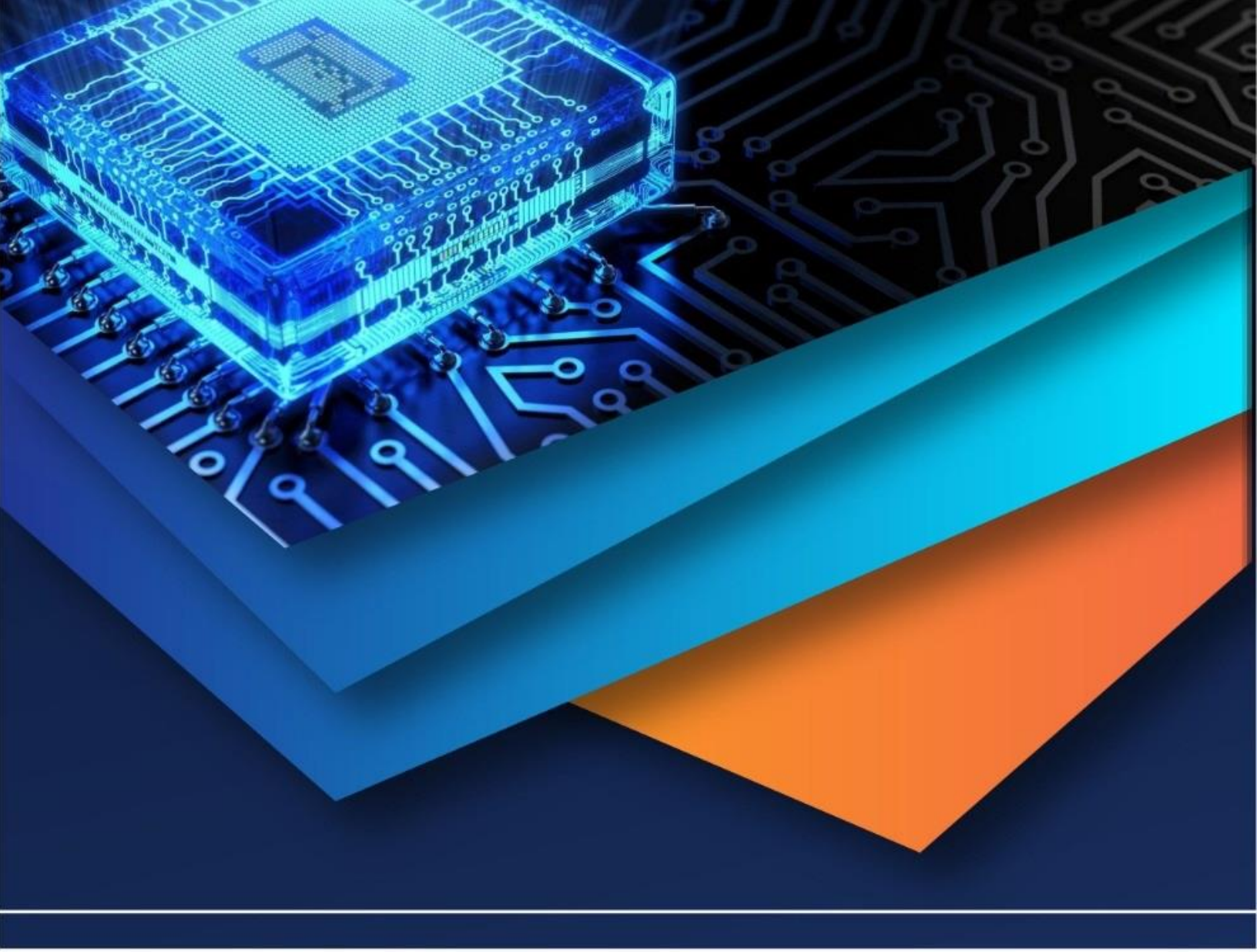
Improvements in the process steps and their distribution by using like MOST helped us to improve the work-station design this both lead to improvement in output of cell. The output of system can be improved by eliminating excessive quality checks.

The satisfactory results of implementation of various lean tools in manufacturing reduce waste of movement and changeover time by 40 minutes per changeover in impeller cell. This has increases the productivity of impeller. This also does not criticize the existing product design, process, quality, reliability and safety.

All the above tools and methodologies are implemented aligning with Cummins Operation excellence program by following various guideline the improvements are achieved, It can be concluded that the operation excellence is an holistic approach to improve a company‘s performance, any organization can achieve excellence in any of their function by structured use of lean tools, though apart from the 5 practices chosen for the project other practices like process capability, 5S can be included to ensure the availability of m/c as well as men at the highest level to improve the manufacturing performance, this area can further be explored by implementing excellence in micro and medium enterprises and creating a structured industry specific approach to achieve excellence in their manufacturing.

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