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An Experimental Analysis on Overall Equipment Effectiveness

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Abstract:- Overall Equipment Effectiveness (OEE) is an indicator to assess the utilization of machinery. This paper's primary goal is to identify and solve the loss elements to enhance the Performance efficiency & Man time. This study aimed at carrying out Gemba walk in the industrial set up to analyse the problems faced by the machine operator and continuous improvement solutios were suggested for the performance enhancement.

I. OBJECTIVE

- To determine the Six Big Losses of Total Production Management and decrease or eliminate them.
- To achieve the greatest investment return in the shortest amount of time and
- To maximize workforce productivity with a real-time, achievable target

II. METHODOLOGY

The methodology involves the collection of data using Gemba walk technique and analyze using Ischikawa Cause and Effect Diagram. The data has been collected in house in thefactory and it aims at action plans to be taken to enhance OEE.

III. LITERATURE SURVEY

Huang S H et al. [1] In this paper the companies to implement various productivity improvement efforts. Implementation of total productive maintenance TPM techniques has led to significant productivity improvements for individual equipment. an approach, based on overall equipment effectiveness OEE, is developed to model the productivity of a manufacturing system in terms of overall throughput effectiveness OTE. Mark C et al. [2] In this paper he put a strategy stating that developing society needsto adapt to change and foster creativity. In the pursuit of continual improvement, he productivity improvements achieved at the equipment level are significant but insufficient because what a companyreally needs is a highly efficient system/factory. This is especially true in the discrete manufacturing industry Huang et al. [3] In the Report that the concept of OEE is becoming increasingly popular and that it has been widely used as a quantitative tool essential for the measurement of productivity in semiconductor manufacturing operations. Many aspects of OEE have been considered as, states that the definition of OEE does not take into account all factors that reduce the capacity utilization, Bangar, Hemlatasahu et al. [5] He had done a case study in Jamna auto industry to improve OEE (Overall Equipment Effectiveness) by implementing Total productive maintenance. After that they reduce 80% problem analyzed by Pareto chart and OEE of industry improved up to 96%. Binoy Boban et al. [6] Proposed a plan to implementation TPM through the various pillars of TPM. They had discussed the 5S and kaizen among the various pillars, After a small implementation of TPM in company, they foundthat the OEE is increased by 4% and also it had been noted that the change in maintenance policy in the company changed their performance and quality Harsha G et al. [7] He had done a case study in improving the breakdown losses of machines through the implementation of TPM in the company OEEand through effective implementation of TPM techniques such as Preventive Maintenance, Cleaning with Meaning, Pokayoke & Kaizen the OEE. Deniels [8] He explains that the way to achievefundamental improvement on the shop floor is to enable operators to establish their own measures, toalign business strategies and to use them to drive their Kaizen activities Teian [9] He describesthat Kaizen is more than just a means of improvement because it represents the daily strugglesoccurring in the workplace and the manner in which these struggles are overcome. Kaizen can be applied to any area in need of improvement. Hammer et al [10] He explains that Kaizen generates process-oriented thinking since processes must be improved before better results are obtained. Improvement can be 54 The Icfai University Journal of Operations Management.

IV. CURRENT STUDY

- *Types of defects in injection moulding components*

- *Short Shots = Short shoots are an occurrence where the Cavity for mould cannot be completely filled.*

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Fig 4.12.1 Short shorts in component

Causes: (1) Die temperature, injection pressure or material temperature and the speed is too slow (2) uneven raw materials plasticization (3) shoddy exhaust (4) inadequate raw material liquidity.

- *2. Air trapped inside a cavity to produce bubbles in the component is known as an air trap.*

Fig 4.12.3 Short shorts in component

Causes: When the two melt fronts collide, it results from the air being unable to escape from the dividing surface, the ram, or the vent.

➢ *Brittleness*

Brittleness refers to how quickly a plastic component can crack or break.

Fig 4.12.4 Brittleness in component

Causes: (1) Conditions that are too dry are not ideal; employ a lot of recycled materials (2) incorrect setting for the injection temperature (3) The settings for the gate and runner system are incorrect. (4)The melting mark's tensile strength is low.

- *Burn Marks*

The burn scars are caused by the inability of the cavity's gas to be quickly expelled, which results in blackening at the flow's termination.

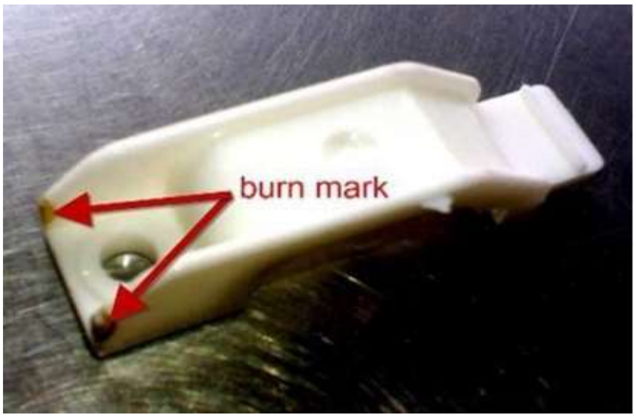


Fig 4.12.5 Burn Marks in component

Causes: (1) It is impossible to swiftly remove the cavity's air. (2) Material degradation includes an excessively high melt temperature, an excessive cast screw speed, and a poorly designed runner system.

- *Flash*

It denotes the presence of extra plastic on the ejector or mould separation.

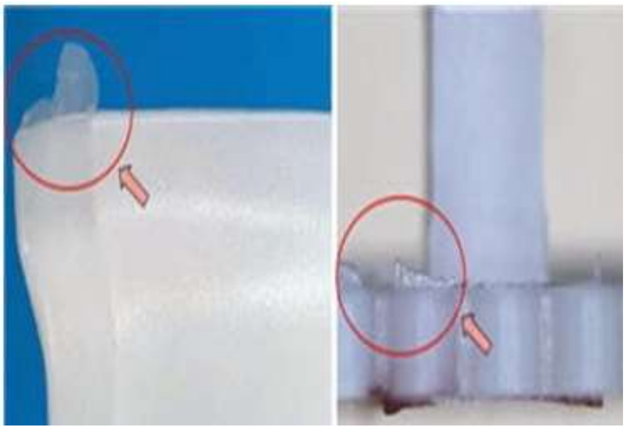


Fig 4.12.6 flash in component

Causes: (1) inadequate gripping pressure (2) The mould is flawed. (3) The hilling.

- *Warpage*

The war page is the most challenging issue to address in the design and production of plastic parts.

Fig 4.12.7 Warpage in components

Causes: (1) Pouring, chilling, and ejection systems comprise the mould structure. (2) Product structure: Changing the wall thickness of plastic parts, having curved or asymmetrical geometry, ribs, and using an unreasonable BOSS column design (3) The plastic pieces are not totally cooled during production, and the injection and pressure holding curves are irrational. (4) Plastic materials: Plastic materials experience shrinkage, even without additional fillers.

➢ *Main root cause for defects and flash occurring*

- *Flash*

A part may flash for a variety of reasons, including as changes in the process or material or tooling issues. Flash appears on the edge of the part along the mould's parting line or wherever the metal in the mould contacts metal to establish the component's border. Recognizing what type of flash you are getting and when it is occurring will help you find the source, which is usually the tool.

✓ Insufficient clamping force
✓ The mould has defects
✓ The mounding.

Flash on part surfaces can be caused by a variety of underlying factors. Many are caused by the mould itself, but others can be made up for by changing the material or injection machine used:

- *Mould Wear Problems*

A worn-out or outdated mould that no longer fits tightly together and allows the plastic to leak out is the most frequent problem that results in flashing. By repairing or redesigning the mould, this is addressed.

- *Mould Design Problems*

A mould can simply be badly constructed, with gaps that lead to flashing, pressure problems brought on by the usage of many parts, or unnecessarily complicated geometries that result in poor fits. It could be necessary to redesign or retool the mould.

- *Pressure and Flow Problems*

Flash may signal pressure or temperature problems in the mould. Dealing with the problem may be made easier by redesigning the mould with better gates or hot runners.

- *Clamping a mould*

Last but not least, the problem can be that the plates are not secured firmly enough to prevent glue from pushing its way between plates. This problem can be resolved by increasing the clamping force of the plate or by transferring the mould to a machine with a stronger clamp.

➢ *Layout optimization to reduce the bin travelling time*

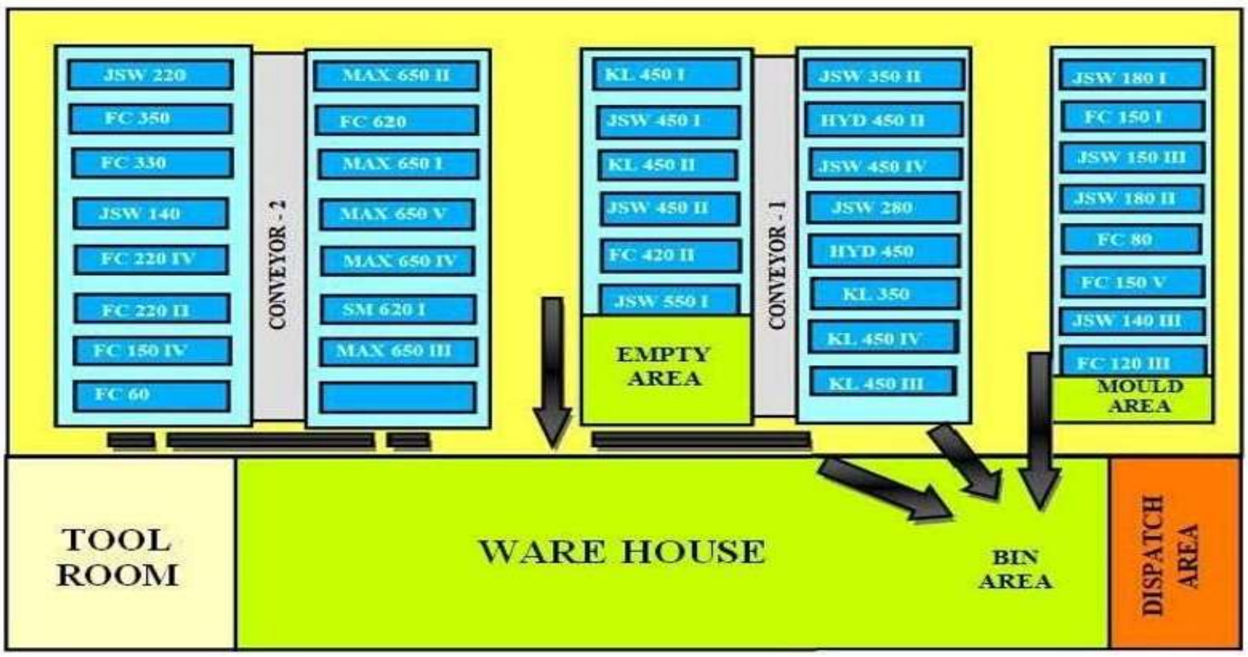


Fig 4.17.5 existing bin travelling movement

Operations layout plays a significant role in the game to create a lean flow and to maximise production from various areas or processes that take place in a warehouse. Using a good procedure in the wrong layout might have negative effects on the area and the business as a whole:

- Bottlenecks
- Slow down the productivity
- Rejections
- Product losses
- Disorganization

➢ *Analysis of the Area's Current Process*

Knowing the warehouse's overall process is vital to make sure the operation of the area to be defined is consistent with and adaptable to the overall process, but it is also necessary to know the specific and detailed activities that take place in the area where the layout is going to be defined.It is crucial to assess the defined process and determine whether it is the right one before beginning to investigate the plant dispersion.

- *Problem solved in cover fan mould and design specification forsolving the problem*

Fig 4.18.1(a) before solving

Fig 4.18.2(b) after solving problem

➢ *Reason for the flash in component*

Due to some dents in the core pin’s work material entering some area around the dent area. Due todents in the core, it’s not properly assembled with the cavity. Due to improper in assembly it createsair gap between Core and cavity. Work material will enter in that air gap and create flash.

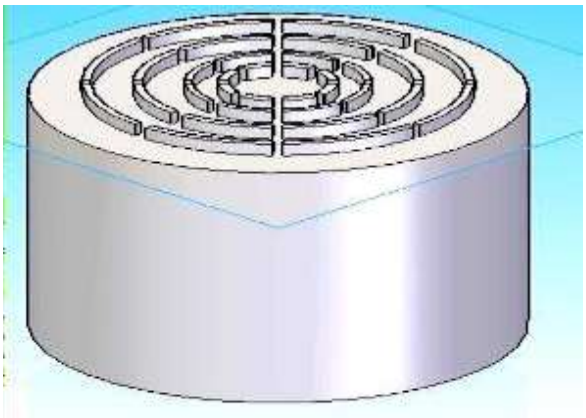


Fig 4.18.3 Core of Cover Fan

A tool called a fan cover core is used in moulding procedures to create internal cavities and re-entrant angles (interior angles higher than 180 degrees). In order to remove the core from the piece, it is often a disposable item that is destroyed. Theyare employed most frequently in, although they are also employed in die casting and injection moulding.

➢ *Design specification of core*

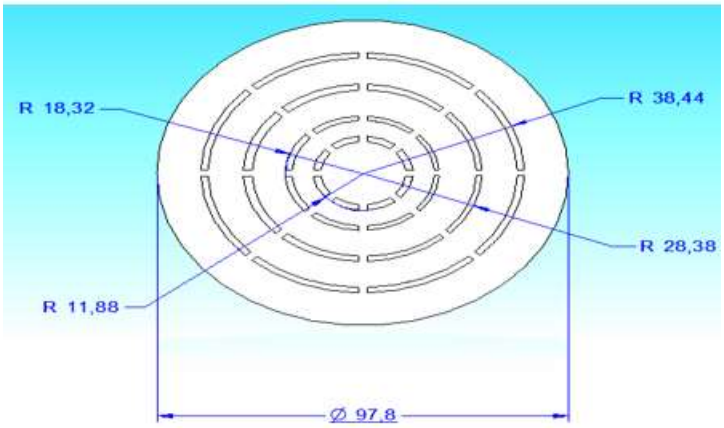


Fig 4.18.4 Top view of core

➢ *Side View of core*

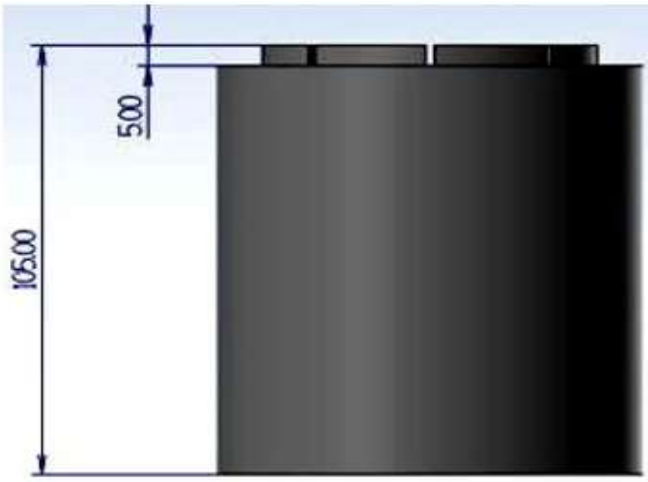
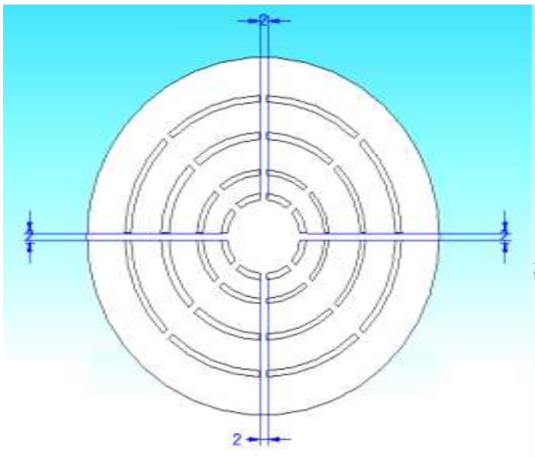
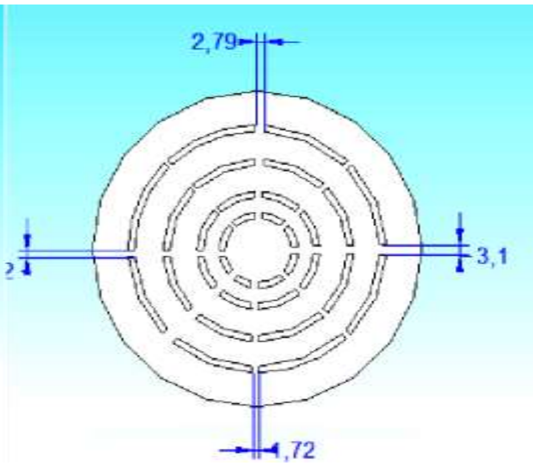


Fig 4.18.5 side view of core



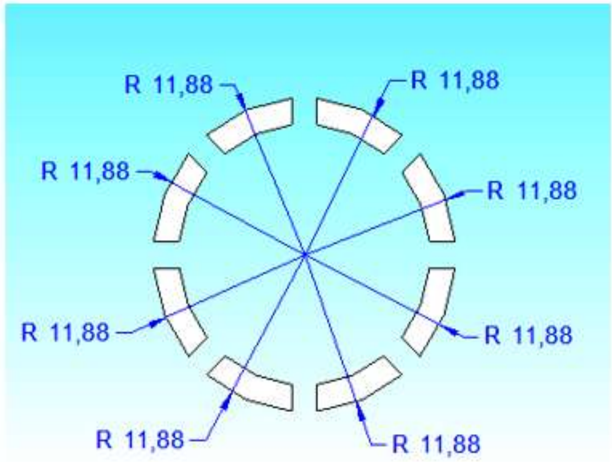
Standard Dimension of Gateway



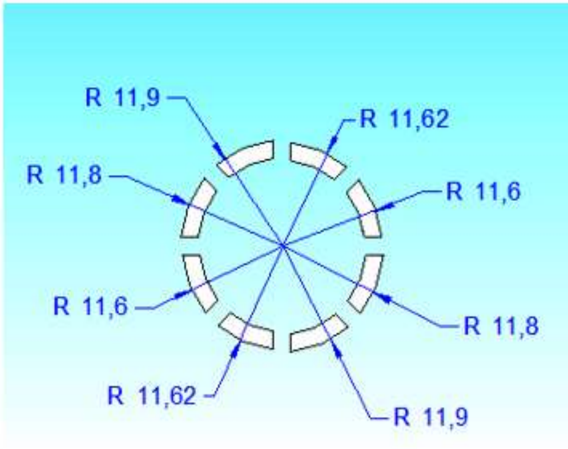
Actual dimension of gateway

Above fig shows that the difference between standard dimension to the actual dimension in the mould gateway. Actual gateway is not having same dimensions in all its gateway area this problemis obtained due to bend in its pins and some of pins are ware out. Due to this problem the work material is entering some places the material was not suppose to enter, due to this the flash is obtains.

➢ *Radius of each pin's to its parallel pin*



Standard Dimension



Actual dimension

Above fig shows that the difference between radius of each pin's to its parallel pin. In the standard arrangement of pins diameter of parallel pins are same to all, but in the Actual arrangement of pins it is not same in all pins. This problem is obtained due to bend tn the pinsand ware out of pins.

➢ *Problem solved in head lamp housing mould and design specification for solving theproblem*


Fig 4.19.1 before solving problem **Fig 4.19.2 after solving problem**

Fig 4.19.3 before solving problem

Fig 4.19.4 after solving problem

➢ *Reason for flash in component*

In Headlamp housing we identify the problem in side core and front pins. In side core hole pin wasware out and it not helping to create holes in side of the headlamp, and same problem occurred in the front pin its dimensions are reduced because of ware and tare in the pin due to mould movement.

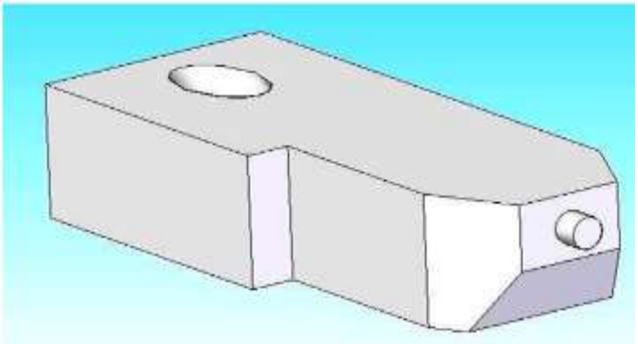
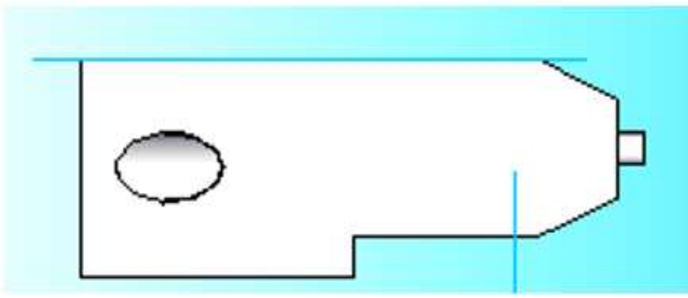


Fig 14.19.5 Side Core

The mold's side core is a component. For the purpose of creating a hole or recess in the side face of a moulding, a sliding core is a local core that is typically positioned at a right angle to the mould axis. This side core prohibits the moulding from being removed in-line, hence a method must be given to remove the side core before ejection It is employed in this mould to enlarge the component's holes.

➢ *Design specification of side core*



Top view

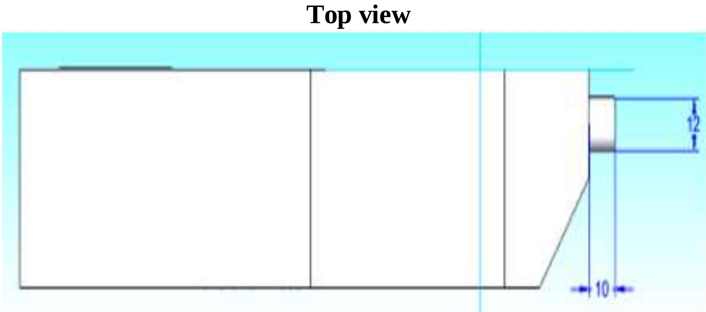


Fig 4.19.6 (a) Standard dimension

➢ *Dimension of side core with punch pin*

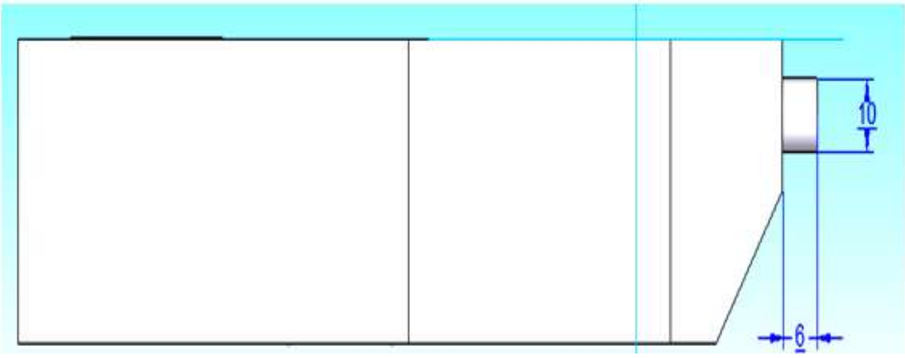


Fig 4.19.7 (b) Actual dimension

1. Fig 4.19.6 (a) standard dimension
2. Fig 4.19.7 (b) actual dimension

Shows that the dimension of the standard pin and the actual pin. Fig 3.5 shows 4mm in length and2mm in diameter difference in actual to standard pin, so in this case the pin has to be removed andreplaced.

➢ *Dimensions of standard and actual punch pin*

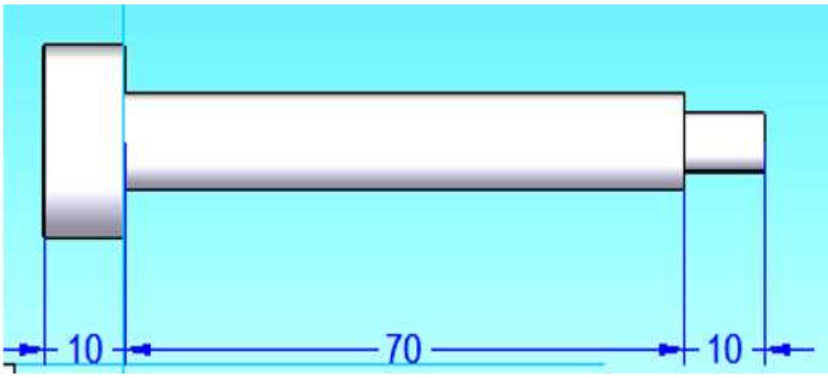


Fig 4.19.8 (a) Standard pin size

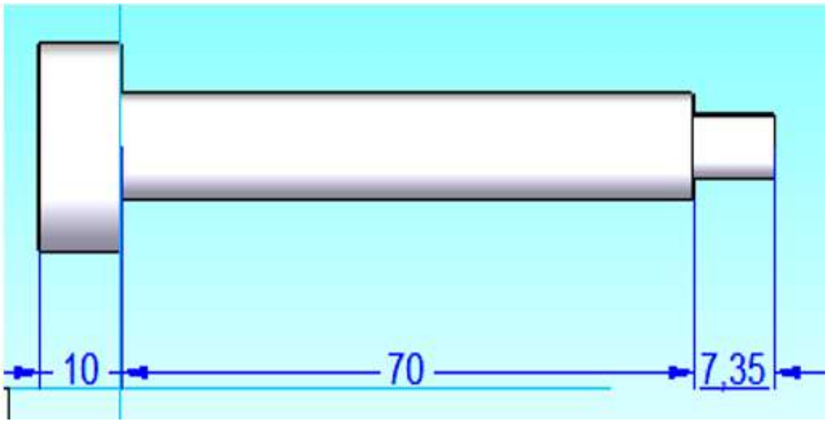


Fig 4.19.9 (b) Actual pin size

Above Fig 3.6 and 3.7 shows that the dimensions of punch pin. Mould has 2 pins in front in those2 pinswas ware out as shown above. The front end of the pin was ware out by 2.65mm in length. In this case we can rework the pin and make the pin acceptable dimension.

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➢ *Problem solved in deflector mould and design specification for solving problem*

Fig 4.20.1(a) before solving problem

Fig 4.20.2(b) after solvingproblem

Deflector is a component which attaches with air filter assembly used attachment for deflecting flowof air, heat.

➢ *Reason for flash in component*

Due to were and tear in pin in the core, the hole is not obtaing properly. This is the reason whythe work material centering to the hole, and creating flash in that area.

➢ *Design specification of side core*

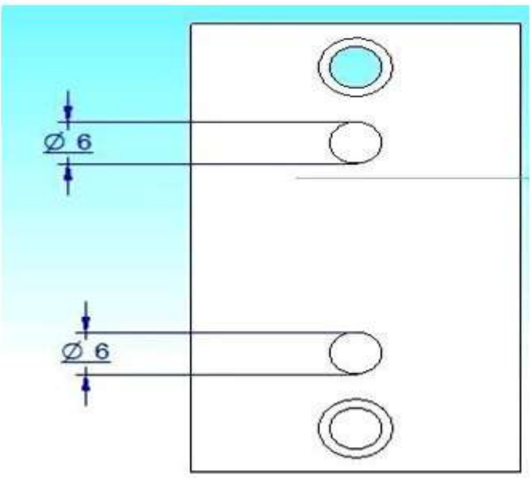

Fig 4.20.3(a) Standard pin size

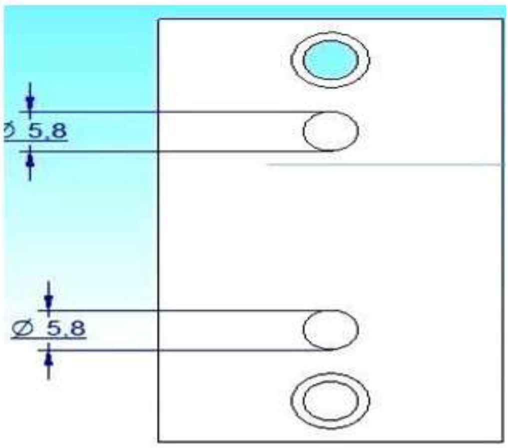

Fig 4.20.4(b) Actual pin size

➢ *Kaizen for layout optimization to reduce bin travelling movement Existing bintravelling movement*

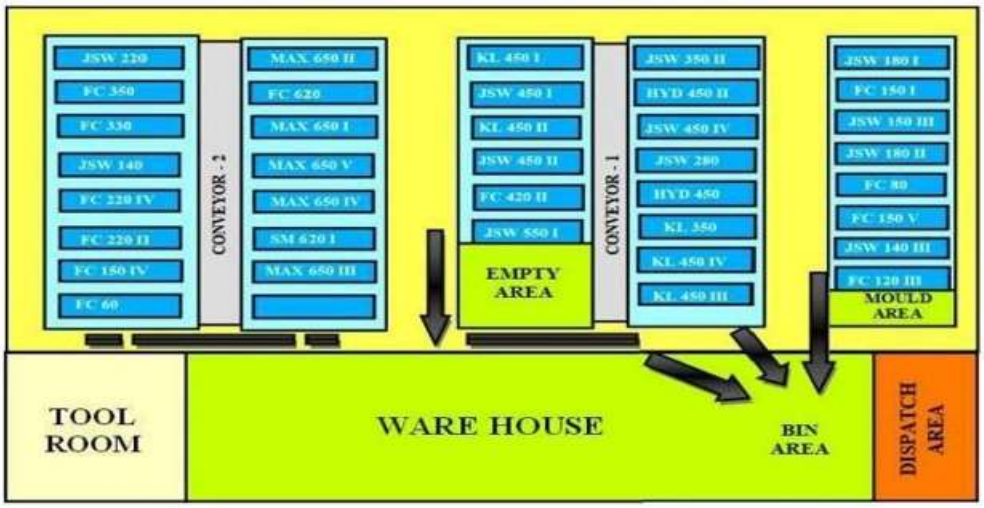

Fig 4.23.1(a) existing bin travelling movement

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Operations layout plays a significant role in the game to create a lean flow and to maximise production from various areas or processes that take place in a warehouse. Using a good procedure in the wrong layout might have negative effects on the area and the business as a whole:

- Bottlenecks
- Slow down the productivity
- Rejections
- Product losses
- Disorganization

➢ *Analysis of the area's present procedure*

To define a good layout, it is necessary, on one hand, to know the global process of the warehouse, to ensurethe operation of the area to be defined is coherent and adapted to the global process, and on the other hand, to know the specific and detailed activities of the area where the layout is going to be defined. Before startingto study the plant distribution, it is important to analyze the defined process and evaluate if it is the appropriate one.

➢ *Optimized bin travelling movement*

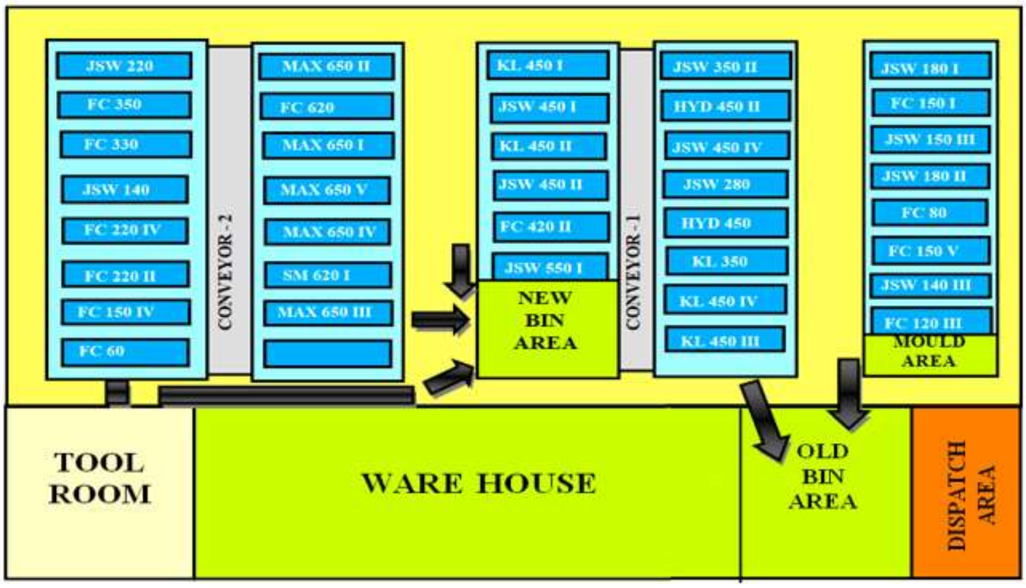

Fig 4.23.2 (b) optimized bin travelling movement

Use of optimization

- Short fill problems can be reduced
- Part rejections can be reduced
- Travelling time for bin can be reduced
- Equal and average distance in optimized layout

➢ *smallest motions*

The process of an area in a warehouse frequently involves numerous steps; It could be viewed as a series of tasks that must be completed in order to fulfill the activity's main goal. To go to the following level, the item and the operators must be moved multiple times. Although they don't provide much value, these motions are important to transport commodities from one station to another.Consequently, it is the goal to minimize them as much as feasible. The less moves made, both in terms of quantity and distance, the quicker this important but unproductive chore can be completed.

➢ *The significance of design*

Understanding the impact of an effective layout on the manufacturing function will help one better comprehend the significance of a layout: It makes it efficient and fluid. A correct layout is essential for operating efficiencies such as reduced material handling costs, reduced production delays, and avoided bottlenecks.

➢ *Advantages of optimized layout*

- *Savings in handling*

Material handling costs contribute for between 30 and 40 percent of the cost of manufacturing. Therefore, every effort should be taken to reduce this expense. Avoid long distance moves, and stop using specific handling techniques. A cynic would assert that the cheapest method of handling materials is to do nothing at all. However, a factory requires the handling of materials, thus everything is dependent on the plan.

- *Effective use of the space available*

Especially in metropolitan environments, every square inch of the plant space is valuable. Therefore, it is important to make an effort to utilize the space by carefully designing the arrangement. Putting equipment and services in strategic locations where they can serve many purposes is one way to accomplish this goal; creation of modern workspaces and operator job descriptions to fully use the labor force.

- *Decrease in production delays*

Prompt order execution will lead to repeat business and new clients. The delivery timetables should be adhered to by all management. The delivery deadlines for production orders are frequently a management headache. An important aspect in the prompt execution of orders is plant layout. An ideal plan avoids delays due to lack of space, lengthy material transportation, and spoilt work, which helps with the quick completion of orders.

- *Enhanced quality assurance*

Orders will only be meaningfully completed on time if the output quality meets or exceeds expectations. To ensure quality, inspection should be conducted at different stages of manufacture.An ideal layout provides for inspection to ensure better quality control.

- *Lowest equipment expenditure*

By installing general-purpose machines, planning machine balance and position, minimizing handling distances, and planning machine loading, equipment investment can be reduced. All these benefits are provided by an effective plant layout.

- *Avoidance of bottlenecks*

Bottlenecks refer to any place in a production process where materials tend to pile up or are produced at a speed, less rapid than the previous or subsequent operations. Bottlenecks are caused by inadequate machine capacity, inadequate storage space or low speed on part of the operators. The results of bottlenecks are delays in productions schedules, congestion, accidents and wastage of floor area. All these may be overcome with an efficient layout.

- *Better production control*

Production Control is concerned with the production of the product of the right type, at the right time and at a reasonable cost. A good plant layout is a requisite for good production control and provides the production control officers with a systematic basis upon which to build organization and procedures.

- *Better supervision*

A good plant layout ensures better supervision in two ways:

- ✓ Determining the number of workers to be handled by a supervisor and 2.Enabling the supervisorto get a full view of the entire plant at one glance.

- *Improved employee morale*

Employee morale is achieved when workers are cheerful and confident. This state of mental condition is vital to the success of any organization.

- *Plant layout has a bearing on all these*

Avoidance of Unnecessary and Costly Changes a planned layout avoids frequent changes which are difficult and costly.

V. RESULTS AND DISCUSSION

➢ *Time Study Before Maintenance Of Mould*

As the time study data was collected we found that deflashing operation consumes more time in total Man time, when the Man time exceeds more time than the Actual running time then the production rate and the performance efficiency decreases of the worker.

Table 5.1 Time study sheet before maintenance

SI No.	1	2	3	4	5	6
Part no	**2184H1270**	**2184H0690**	**2184D0170**	**2184T0750**	**2184H1260**	**2184C4560**
Part name	**Cover Fan**	**Head lampfront**	**DeflectorRH/LH**	**Tail CoverLUG RH- LH**	**HousingFan**	**Cover FuelTank Outer**
PED time	**40**	**35**	**28**	**45**	**75**	**55**
Actual running	**45**	**37**	**34**	**55**	**50**	**49**
Difference PED actual	1	9	6	10	-25	6
Deflash	30	24	15	13	36	35
Man time	**50**	**46**	**34**	**24**	**65**	**53**

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➢ *Time study after maintenance of mould*

As we worked on how to control the flash which is waste of deflashing time, After the preventive maintenance of the mould tool we assume that it will reduce the deflashing timeup to 50-60% as of before which will reduce the total Man time then the Actual running time. This will improve the production rate and performance efficiency of the worker.

Table.5.2 Time study sheet after maintenance

SI No.	1	2	3	4	5	6
Part no	**2184H1270**	**2184H0690**	**2184D0170**	**2184T0750**	**2184H1260**	**2184C4560**
Part name	**Cover Fan**	**Head lampfront**	**DeflectorRH/LH**	**Tail CoverLUG RH- LH**	**HousingFan**	**Cover FuelTank Outer**
PED time	**40**	35	28	45	75	55
Actual running	**45**	**46**	**34**	**55**	**50**	**49**
Difference PED actual	1	11	6	10	-25	6
Deflash	**10**	**12**	**5**	**8**	**18**	**10**
Man time	**40**	**25**	**24**	**24**	**65**	**53**

➢ *After plant workshop optimization*

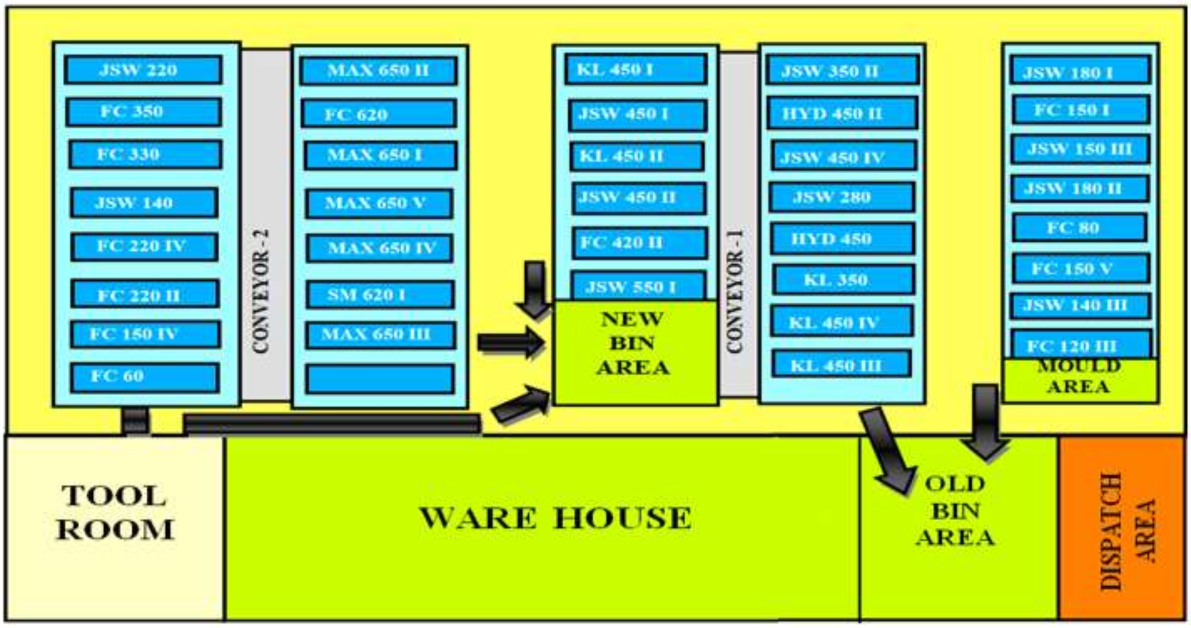

Fig 5.3 Plant Workshop Optimization

After the optimization of the plant workshop layout, this will reduce the maximum distance and Mantime for the right side machine workers, which will increase the productivity and performance efficiency of the worker.

➢ *After optimization of plant work shop*

- Short fill problems is reduced
- Part rejection due to short fill is reduced
- Travelling time for bin is reduced for all the lines
- Equal and average distance
- Increase the productivity and performance efficiency of the worker.
- Helps to reduce the man time and indirectly helps to increase the OEE

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Table shows the difference between optimized and un optimized binarea

Table 5.3 Man time of bin movement for before and after optimization

Man Time			
Machines	**Time to get 12 empty bins in sec**		
	Before	**After**	**Difference**
JSW 550 I	**200**	**50**	**150**
FC 420 II	**220**	**60**	**160**
JSW 450 II	**220**	**60**	**160**
KL 450 II	**230**	**70**	**160**
JSW 450 I	**240**	**80**	**160**
KL 450 I	**250**	**80**	**170**
MAX 650 II	**250**	**80**	**170**
FC 620	**240**	**80**	**160**
MAX 650 I	**230**	**70**	**160**
MAX 650 V	**220**	**70**	**150**
MAX 650 IV	**220**	**60**	**160**
SM 620 I	**200**	**60**	**140**
MAX 650 III	**200**	**60**	**140**
FC 60	**280**	**100**	**180**
FC 150 IV	**290**	**120**	**170**
FC 220 II	**300**	**130**	**170**
FC 220 IV	**300**	**150**	**150**
JSW 140	**320**	**170**	**150**
FC 330	**330**	**180**	**150**
FC 350	**330**	**180**	**150**
JSW 220	**340**	**210**	**130**

➢ *Time consumed before and after optimization*

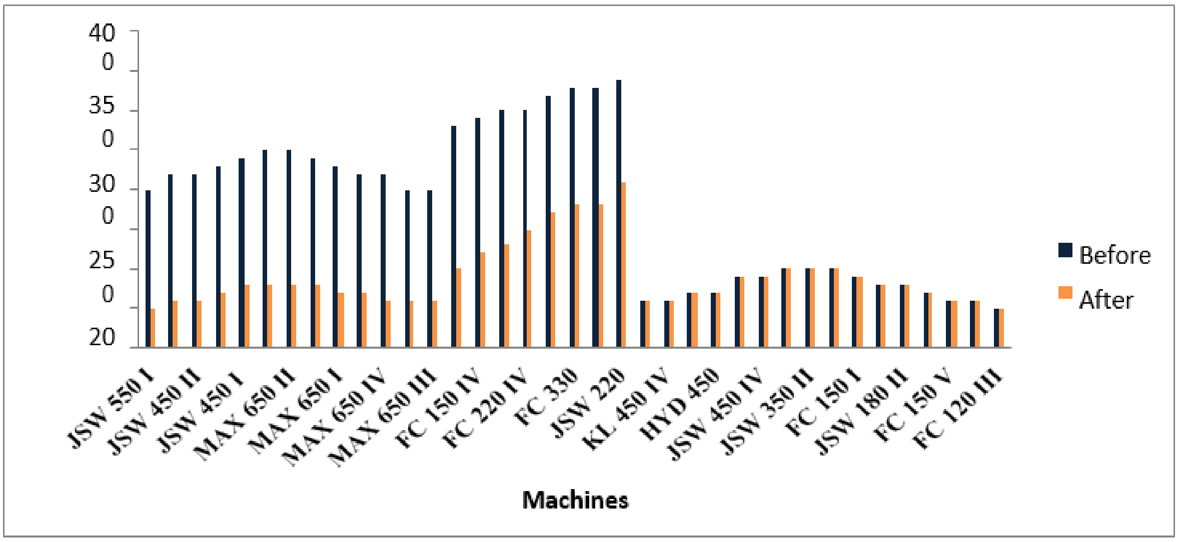

Fig 5.5 histogram for optimization bin area

The histogram represents the optimization of bin area in x axis it represents the machine and Y axis representstime in seconds. We can see that the time has been balanced.

Total time consumed before and after optimization

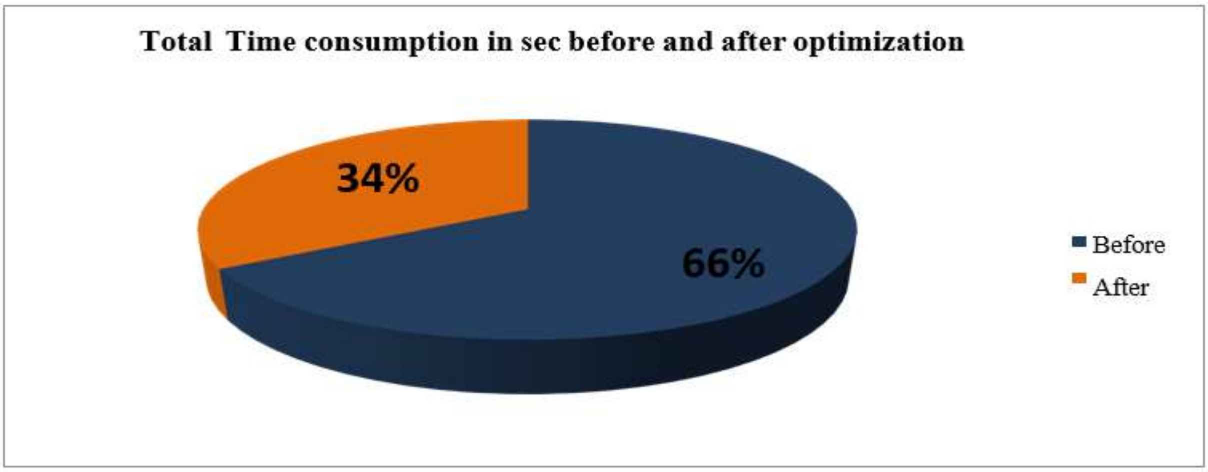

Fig 5.6 Comparison of time in seconds before and after optimizing

The graph shows time consumption in seconds the blue indicates the before optimization timewas taking around 66% and yellow indicates the after-optimization time was taking around 34% we cansee that time has been optimized 32%.

- *Before maintenance PED, actual time & man time for the followingcomponents*

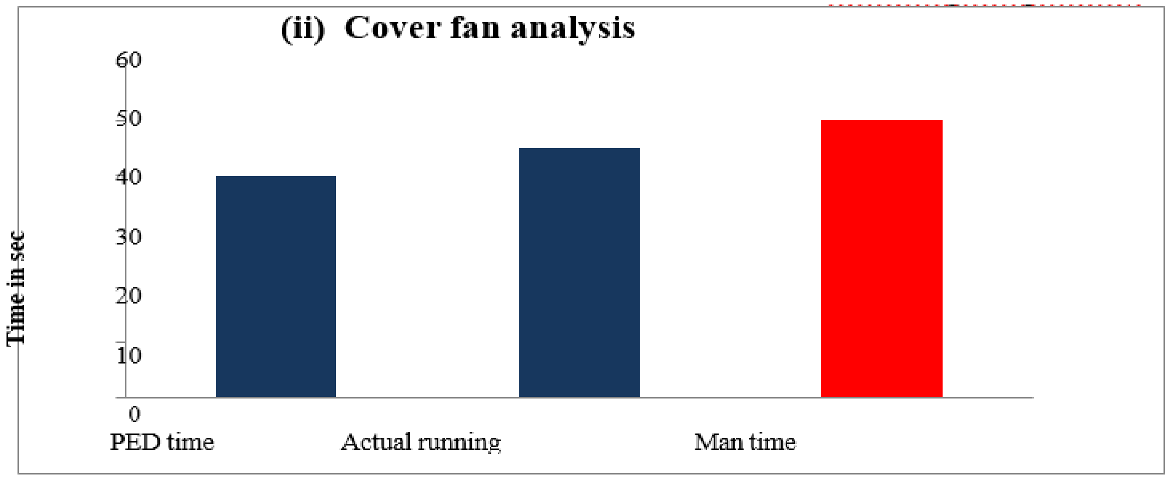

Fig 5.7.1 histogram for cover fan

In the histogram X axis represents the PED time, actual time, man time and Y axis represents time in seconds. In graph we can see that man time 50 sec is exceeding the actual time 45sec which results in theloss of OEE.

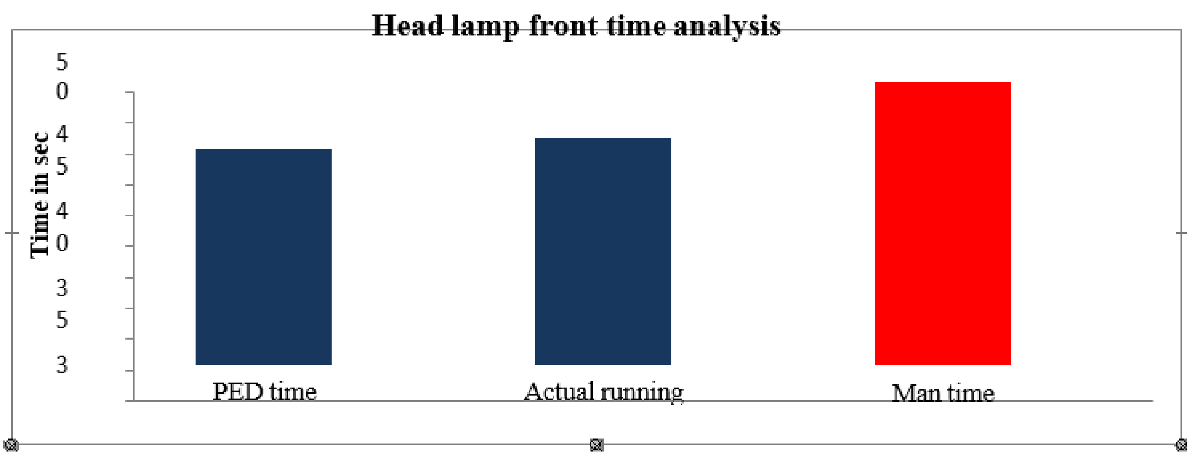

Fig 5.7.1 histogram for cover fan

In graph we can see that man time 46 sec is exceeding the actual time 37 sec which results intheloss of OEE.

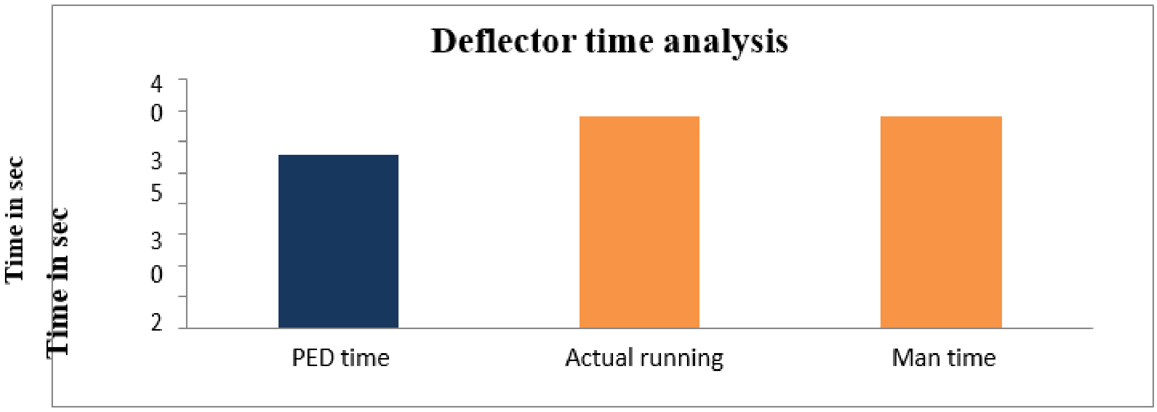

Fig 5.7.3 histogram for Deflector

In graph we can see that man time 34 sec is exceeding the actual time 34 sec both the timehasbeen balanced but the OEE cannot be achieved.

- *After maintenance PED, actual time and man time for the followingcomponents*

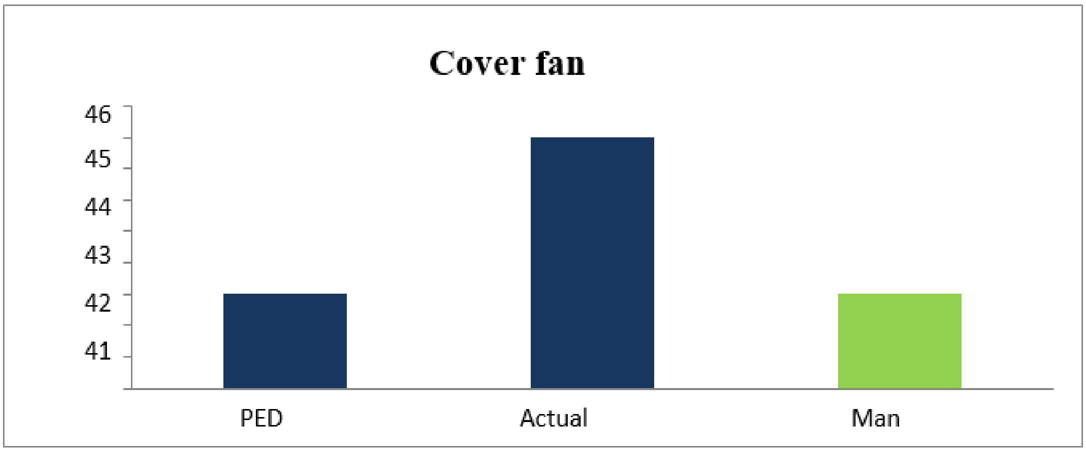

Fig 5.8.1 histogram for Cover fan

In graph we can see that man time 40 sec is not exceeding the actual time 45 sec it hasoptimized up to 5 sec which helps achieve the OEE.

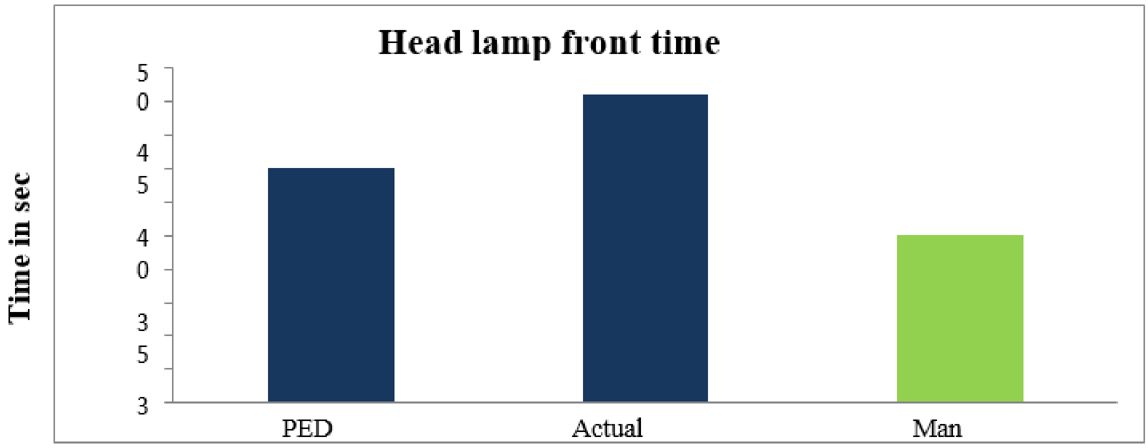

Fig 5.8.2 histogram for Head lamp front

In graph we can see that man time 25 sec is not exceeding the actual time 46 sec it hasoptimized up to 21 sec which helps achieve the OEE.

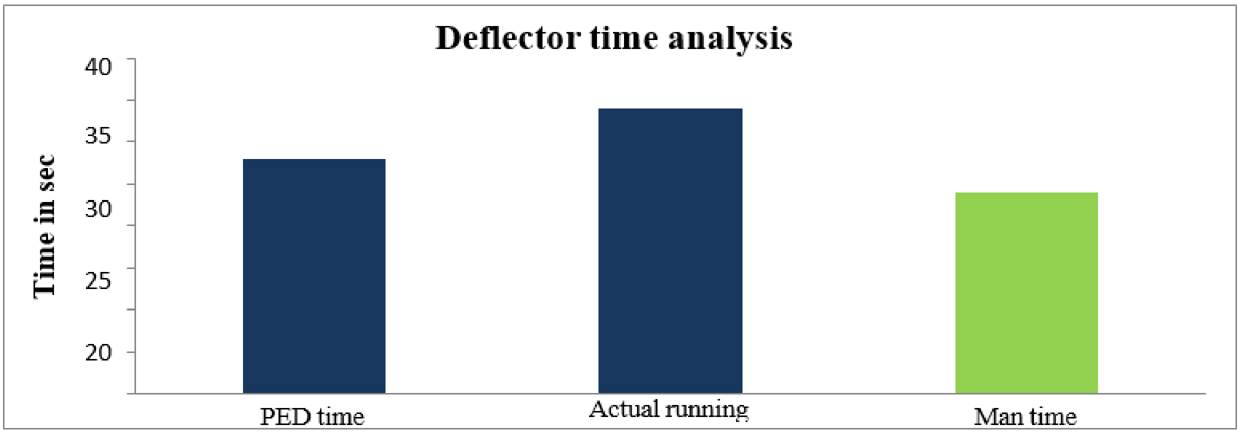

Fig 5.8.3 histogram for Deflector

In graph we can see that man time 24 sec is not exceeding the actual time 34 sec it hasoptimized up to10 sec which helps achieve the OEE.

VI. CONCLUSION

The initiative provides the business with a new, significant step in improving performance efficiency. When we came together as a group, the organization had the opportunity to observe how crucial teamwork is to solving difficulties. To determine the Six Big Losses of Total Production Management and decrease (or perhaps eliminate) them. To maximize return on investment in the shortest amount of time possible. To increase employee productivity It might offer operators a live, attainable goal. The opportunity to learn about the top methods they can use to enhance their performance is another advantage of the project.Enhancing OEE also enables the business to identify its strengths, weaknesses, and improvement opportunities.

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