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Study and Analysis of Lean Tool (Six Big Losses) Smed Implementation in Bar Rod Mill

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ABSTRACT:-Metal forming process plays important role in manufacturing industries to give the required shape to the material. In present day we require high strength material with low cost to meet the demands of the competitive world with the maintenance of high quality. In manufacturing industries to meet the above demand they are standardizing their process of the material by avoiding lot of wastes by using total quality management tool ie., Lean Manufacturing. Lean Manufacturing technique tools are widely used in the Industries today to save time, money and material. In metal forming process, bar rod milling process where the steel rod from 5.2mm to 22 mm can be obtained. However for the bar rod mill lot of mechanical, electrical operations will be carried ie., reheating furnace, rolling the rod in different sized mill to reduce 165 mm to 5.2 mm – 22mm, surface finishing, packing etc., Hence tool changing, maintenance and shut downs will happened then it leads to delay of the process will happen and this can be avoided by using lean manufacturing tool ie., SMED (Single minute exchange of dies), JIT (Just in time), Six Big losses to analyses and find the required solution to the problem faced by the production engineer.

However solutions of the wastes occurring in the manufacturing process will be obtained by TQM techniques like brainstorming, PDCA, bench marking etc., will also improve the process. Lean technique- Six big losses analysis application will provide the total losses from material procurement to dispatch process losses occurred in the industry which will benefit to the organization in gaining the profits.

Key words:- steel industries JSW, TQM technologies like TPM, Lean, six Sigma etc,SMED technology.

I. INTRODUCTION:-

Jindal Steel works(JSW) Overview:India is the second largest producer of steel and growth is due to the raw material availability and the cost effective labour. The Indian steel industry is very modern with state of the art steel mills. It has always strived for continuous modernization and up gradation of older plants and high energy efficiency levels.Jindal steel works belongs to O.P Jindal Group and has grown to US $ 5 billion in a decade period and it has presence in various sectors like Steel, Energy, Minerals, Port & infrastructure, Aluminium and IT.Jindal Group set up its first steel in 1982 at Vasind near Mumbai. The Jindal group who had wide experience in the steel industry, renamed it as Jindal Iron and steel Co.Ltd(JISCO). In 1994, in order to achieve the vision of moving up the value chain and building a strong resilient company, Jindal Vijaynagar Steel Ltd (JVSL) was step-up, with its plant located at Toranagallu in the Bellary Hospet area of Karnataka, the heart of Iron ore belt nad spread over 3,700 acres of land.

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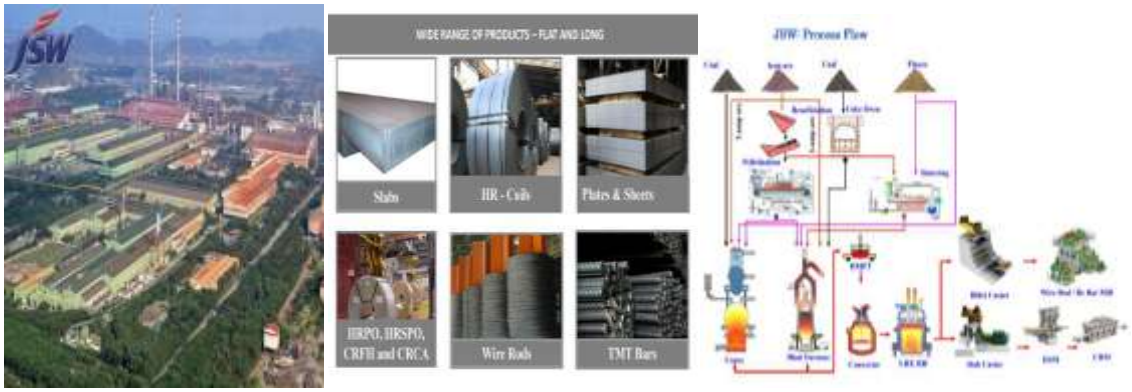

Figure 1.1 Jindal steel works -Vijaynagar plant located at Toranagallu in the Bellary Hospet area of Karnataka:Jindal Steel works produces the below steel products -Figure 1.2 Products of JSW Steel works:Figure 1.3 JSW Process Flow.

JSPL has its own steel making unit producing steel through the EAF-LRF-VD-CCM route with fully automated control system backed by computerized level II process models. These models ensure that steel is always produced within consistent composition band. Steelmaking at JSPL is supported by two Blast Furnaces with 1.60 million tonnes per annum of hot metal capacity and DRI (Sponge Iron) plant of 1.37 million tonnes per annum capacity. JSPL's steel melting facility is equipped with three Electric Arc Furnaces (EAF) of 100 tonnes capacity each. Equipped with Supersonic Lance and Carbjet facilities, the furnaces have eccentric bottom tapping feature which ensures slag free tapping of steel. Owing to usage of metallics based on virgin iron ore from captive mines and only plant return scrap (no outside scrap), very low level of inclusion and tramp elements are achieved, thus generating high quality clean steel. Steelmaking facilities have 4x100 MT Ladle Refining Furnaces (LRF), used for carrying out the steel refining operations including desulphurisation.Continuously cast square billets of 165mm size are used for wire rod rolling, which are cast in a six strand billet caster.The caster is equipped with Electromagnetic Stirring (EMS) facility which minimises centre line segregation and thus ensures uniform properties in wire rods as well as in the finished wires.

1.1 Bar rod mill process:-

In this generally billets are converted into TMT rods. This is done under the technique that heating the billet from SMS in the reheating furnaces and reducing the dimensions of the bars by using vertical and horizontal rollers. Rapid cooling is done to retain their strength and toughness. In this process stress is generated due to reduction in the dimensions and strain is also retained in the TMT rods so that every place stress breakers are fitted so that relieves the stress and make the rods stronger. Cutters are used to cut the rods at specified lengths. And then they are sent to delivery section.

Figure 1.5 Bar rod melting process Figure 1.6 Finished products of bar rods packed for dispatch

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1.2 Total Quality Management Principles application for continuous improvement in the Process of the Industry:1.3.1 Introduction of TQM: Total quality Management means that the organisation culture is defined by and supports the constant attainment of customer satisfaction through an integrated system of tools, techniques, and training. This involves the continuous improvement of organizational process resulting in high quality products and services.

Six basic concepts of TQM: Management commitment to TQM principles and methods & long term plans for the organisation:Focus on customer:Quality at all levels of the work force:Continuous improvement of the production/business process:Treating suppliers as partners:Establish performance measure for the Process.

1.2.1 TQM Evolution:Evolution of mankind and economics:-

- Hunting – Not organised, solution to problem approach, one to one
- Agrarian- Organising at small levels, benefits to productivity
- Industrial- Harnessing scientific tools, further improvement in productivity
- Knowledge- Organising capability harnessing knowledge with management tools with technology
- Evolution of the concept of Quality Management
- Quality control – includes scientific management, inspection, statistical sampling
- Quality assurance – includes organisational quality
- Quality management systems – customer driven quality
- Total quality management – six sigma, lean etc.,

Figure 1.7 Evolution of TQM

1.2.3 Quality management and improvement philosophies: Quality management tools developed to reduce not only defects occurred in the manufacturing but also increase the process standardization for the product based industries.The below figure shows the tools of Quality management and improvement tools

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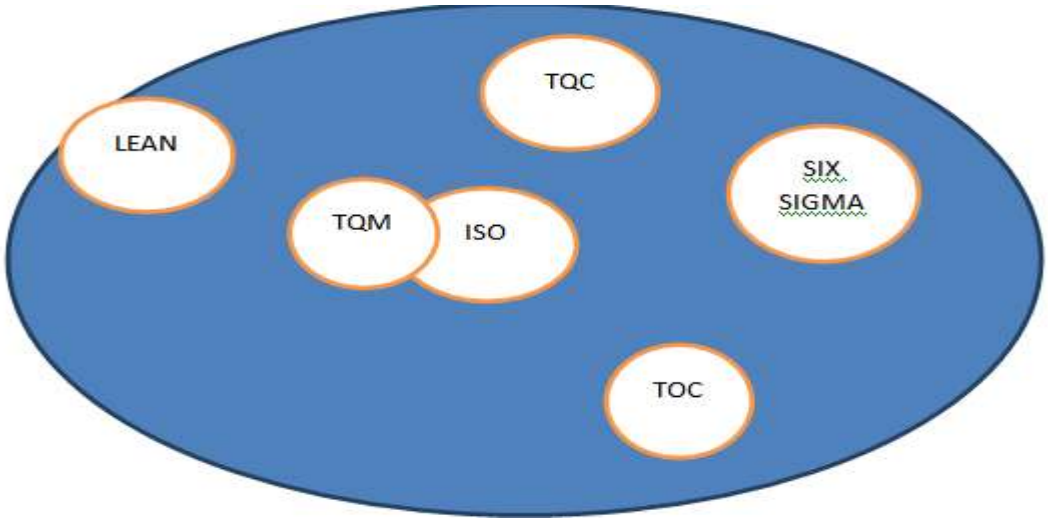

Figure 1.8 Quality Management tools and philosophies

1.3 Lean manufacturing application in JSW:-

1.3.1 Introduction:

Lean is a philosophy that seeks to eliminate wastes in all aspects of an organisation's activities – Manufacturing, management of material and inventory etc.,

5 Principles of Lean:

1. Value- Specify what creates value
2. The value stream –identify all the steps along the process chain
3. Flow- make the value process flow
4. Pull – make only what is needed by
5. Perfection- Strive for perfection by producing exactly what the customer wants

1.3.2 Seven wastes of Production and services-

In Lean manufacturing we consider seven types of wastes to avoid consider both in Production and services:

Seven wastes of Production	Seven wastes of services
Over production	Delay- customer waiting for service
Waiting time	Duplication- rework, repeat entries etc.,
Transport	Unnecessary movements –ergonomics
Process	Unclear communication – Clarification, confusion over use of Product/service
Inventory	Incorrect inventory – out of stock
Motion	Opportunity Lost – retain customer
Defective goods	Errors- lost/damaged, in transaction

Table 1.1 Seven wastes of lean

1.3.3 Lean tools implementation:-

The below are the lean implemented in the industries to improve the overall efficiency effectiveness of machine-

- Andon is a visual feedback system which gives the information about shop floor regarding status of the production, alert for emergency and information to the operators to stop the process of production.This tools is mainly using in the shop floor for communication purpose that makes the workers alert for the problems occurring in the plant floor/shop floor and then the operators can able to solve the problems occurred.

- Bottleneck Analysis – Lean tool which can identify part of the manufacturing process whether it is in the overall throughput and also guides to improve the performance of the part identified in the manufacturing process.The throughput which strengthening weakest link in the manufacturing process.
- Continuous flow – the lean tool in work in process i.e., manufacturing process flows smoothly with the minimal buffers between the stages of the manufacturing process. For achieving the continuous flow,forms of waste ie., inventory,waiting time and transport etc., has to be eliminated for the smooth flow of process
- Gemba – All the employees need to know where the actual production of works happening in the organisation instead of sitting in the office and spending the time to improve the individual skill and also to improve the organisation by understanding the manufacturing issues and solving techniques.This can be achieved by observation and taking to the shop floor employees.
- Heijunka – lean tool which helps in the scheduling the production process that manufactures smaller batch products by sequencing different products within the same process. This process reduces the lead time i.e., the manufacturing duration of the produce and inventory (because of the small quantity).
- Hoshin Kanri – this lean tool mainly involves in the policy deployment. It mainly aligns the company goals i.e., strategy for company growth, with middle management tactics and the plant floor work performed by the workers. This tools helps in ensuring whether the goals is consistent and thorough by eliminating wastes by good communication between the management and the employees.
- Jidoka – This tool mainly involves in the partial automation design to reduce the labor cost with less investment than full investment and to stop the process when defects are detected.With the help of automation workers are frequently can monitor the process for different manufacturing products at one time and reduce the defects maximum.
- Just in Time – This tool in short form defined as JIT. It mainly directed the organisation to produce the products as per the customer demand when he required. It is just as fast food everything is ready when customer requires he serve the food. This tool reduces the inventory and improves the flow of cash. Due to reducing the inventory space requirement also reduces improves the efficiency of the manufacturing.
- Kaizen – It mainly involves the employee involvement to achieve the improvements in the manufacturing process. By combining the talents, skills of an organisation to create the new product and also eliminating wastes in the existing manufacturing process will achieve continual improvement
- Kanban –the procedure of flow of goods both in the industry, suppliers and customers is defined by Kanban system. Through the Kanban cards the workers will come to know the quantity of goods to be produced. This eliminates the wastes of inventory and over production.
- KPIs- This tool helps to extract the important metrics to track and monitoring the progress regarding the critical goods /goals of the organisation. These are important for the management what are the things they need to do immediately and KPIs are powerful drivers of behaviour based on the importance.

The below KPIs are important to improve the efficiency of the organization

- For top level KPIs ie., goals of the organization which helps management to improve the organisation
- Middle level goals which improve the overall equipment effectiveness and
- Low level which improves the production

- Muda – This tool helps the workers to know the wastes in the manufacturing process that is no value for customer requirement. Muda ie., waste which needs to be eliminated which is the primary requirement of lean manufacturing.
- Overall Equipment effectiveness – It is a framework for measuring the productivity losses in the manufacturing process.

To measure the above effectiveness the below detail are required Availability, Quality and performance of the production. By knowing the above we can make assure to customer for 100% effectiveness in the production.

- Plan, Do, check and Act – Short form PDCA. It is an methodology for implementing the improvements

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Plan – In plan we need to establish the plan and expected results ie., forecasting the plan.
Do – in this the implementation of the plan already established
Check- examine the results achieved in the plan
Act – review of the plan and again redo if any deviation in the process

- Poka Yoke – It is design error detection and elimination in the production process with goal of elimination of defects to zero. This process is difficult because of finding all defects by inspection and correcting the defects.
- Root cause analysis – this tool is a problem solving tool which focuses on resolving the problems by digging the cause of the problem. It is a common approach by asking why 5 times. Problem can be eliminated by application of corrective action to the root cause of the problem.
- Single minute exchange of dies – This tool mainly works to reduce the setup /change over time to less than 10 minutes and the below steps helps in this regards
  - Converting setup to the external ie., performing the parallel activities
  - Simplifying the internal setups by replacing bolts with knobs and levers
  - Elimination of unnecessary operations in the process.
  - Improving for standardized instructions for workers.
- Sib big losses- This tool mainly gives the information about the losses occurred due to delay in the process and those are –Planned stop, Unplanned stops, Small stops. Slow cycles, startup rejects and production rejects. By knowing the wastes occurrence and the workers can eliminate the same
- SMART goals – This tools main involves in the goals achievement and the full of indicates the inspiration for the workers.

SMART goals means our goals need to be specific, measurable, attainable, relevant and time specific. This is not only improve the goals of the organisation but also improve the skills of the workers

- Standardize work – the process need to be documented by capturing the information by all the management levels to complete the task. Document that will communicate all the workers what to do in the shop floor clearly.

This communication eliminates wastes by applying best practices. It will be a baseline for improvement in the future process/activities.

- Takt time- the place of production that aligns the production as per the customer demand. It is the ratio of planned production time and customer demand.

Provides method of production pacing. It extends to improve an efficiency goal for shop floor ie., ratio of actual pieces and target pieces.

- Total productive maintenance – It is an approach to maintenance which focuses on proactive and preventative to maximize the operational time of the equipment. This in short form as TPM. It will distinct the difference between the production and maintenance to help the operator to maintain the equipment.

This environment helps the workers to improve their involvement to improve the productivity by increasing up time, reducing cycle times and eliminating defects.

- Value stream Mapping - This tool helps to visualize the present and future state of processes to improve the areas of organization.

It will show the wastes in the present processes and road map provides for the improvement in the future process.

II. LITERATURE SURVEY:

S.Pramila Studied the development of steel industry in India and how they impact on the economic growth. In the paper, explained types of raw material available in India to utilise for our economic growth and how they have been utilising in the industry. Steel industries available in India and the drastic improvement in India during the period 2001-2010 and it has been continuing till the date. Many new projects developed in India to improve the steel industries[1].**Nimish Dhomne** Explained the rolling process for the steel products. Various operations carried in the rolling process. Optimization of the process explained by arranging the rollers in the vertical and horizontal direction and various stoppage occurs in the process. How the stoppages can be reduced to improve the process of hot rolling.Improving the effectiveness of the rolling machine by reducing the temperatures explained in the research**[2].Pekka Tervonen**have studied the Total Quality Management application in different case studies in the production. Started with the Quality management system where the entire organisation will not involve in the Quality of the product and process whereas in total qulity management entire organisation involvement to

develop the quality in all aspects in the production. In the paper explained the TQM implementation and the improvement in the process development**[3]**,**R Sundar** studied the concept of lean manufacturing for maximizing the resource utiliziation through minimization of waste to face the fluctuation and competatice business environment. In the paper cleared mentioned in any organization meet the above demand, the process must be systematically and continuously respond to these changes. Hence implementation a lean has becoming core competency for any organization to sustain. How the lean technologies implementation have been Developed and the lean technologies like SMED, Kanban. Key product Indicators, Pull system and production levelling system, in line balancing etc., explained. However these technologies will help organization not only to improve the standards of the process but also the standards of employees skill improvement which may improve organization standards to meet the demands of the competency world in the manufacturing of any product. These new technologies gives the basic idea where the mistakes happening, new technologies implementation to avoid these mistakes to improve the standards of the process**[4]**.**Souza** have implemented SMED technology in auto industry. In the implantation of technology explained how the technology can be applied without depending on the other tools to achieve the gools. In the application reduced 46% of set up time in the industry which reduced investment for the organisation and improve the standard of operation. For carrying out research lot of data captured in the process, analysed reached the goal but not to the objective time and again the same technology applied and improved the application of the technology to reach single digit. And review lot of literature and applied to improve the standards of lean application in industries and services**[5]**.

III. OBJECTIVES & METHODOLGY:-

Objectives of the Project Work are as follows.

- To study different metal forming process in the steel industries
- To study how they are impacting in the growth of India economy.
- To study about the long products like wire, rod, billets etc., in the steel industry
- To studied the process of bar rod technology in JSW and its mechanical, electrical operation implementation for production.
- To know different kinds of operation which happening to make the process delay in the production.
- To know how they were implantation new technologies like TQM in their organisation.
- To know TQM department involvement in solving, training the employees to achieve their mission & vision in the organisation to meet the competency of the world.
- To know how the TQM tools like Pareto diagrams, scatter plots, control charts, flow charts,cause & effect diagram, Fish bone diagram, Histogram, check lists etc., to analyse the delay report.
- To know how the TQM technologies like TPM, Lean, six Sigma etc., implantation in the organisation
- To know how the SMED technology implanted in solving the reduction of delay in wire rod mill & bar rod mill.
- To studied different kinds of lean technologies like JIT, Kanban, Pull system. SMED and six big losses and implement according to the problems arise in the process standardization.
- To know stages wise implantation of single minute exchange of dies in the industries to improve the delay reduction technologies
- To know and implementation of six big losses technology implantation for the same case study to improve more than the SMED.
- To know how to give training to the Employees for implementating these technologies in the industry.

3.1 Methodology of the Project Work:

Stage 1: Literature survey help us what kind of technologies implementation for the case study given by JSW.

Stage 2: Analysis of the SMED tool which was already applied in the study but reduced only 23 min

- Problem identification in long products mills like wire rod mill and bar rod mill.
- Describing the objective/aim i.e., to reduce the delay due to ring change (16% of total delay) other than mechanical(21%), electrical (14.82%) and operational delay (12%) which leads to reduce the production by 0.2MT /annum which leads the loss of 10 crs approximately.
- This reducing of the delay may leads to reduce the loss not completely but little.
- Taken the readings of the ring change over by videotaping and deploying observers on the shop floor
- And the same has been uploaded in the computer by using Gantt chart with the activities start and end time

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- In the observation by the engineers some activities are external and others can be improved by eliminating wastes
- Streamlining all the activities by ECRS (Eliminate, combine, rearrange and simply) method
- Last step documentation and standardize the process and checking the results (PDCA) and standard deviation.

Stage 3: For the above analysis TQM department used TQM tools like Histogram,Gantt chart, check list etc., for analysis to reduce the delay
Stage 4: For the problem given in stage 2 can be improvised by the another lean manufacturing tools ie., six big losses.
Stage 5: Six big losses technique studied and suggested to reduce the delay not only ring change pass over but also in all other mechanical, electrical and operational delay can also be reduced by analysing the data captured by the engineers.

3.2 Bar rod mill process: In this generally billets are converted into TMT rods. This is done under the technique that heating the billet from SMS in the reheating furnaces and reducing the dimensions of the bars by using vertical and horizontal rollers. Rapid cooling is done to retain their strength and toughness. In this process stress is generated due reduction in the dimensions and strain is also retained in the TMT rods so that every place stress breakers are fitted so that relieves the stress and make the rods stronger. Cutters are used to cut the rods at specified lengths. And then they are sent to delivery section.

Bar rod mill process flow chart:-

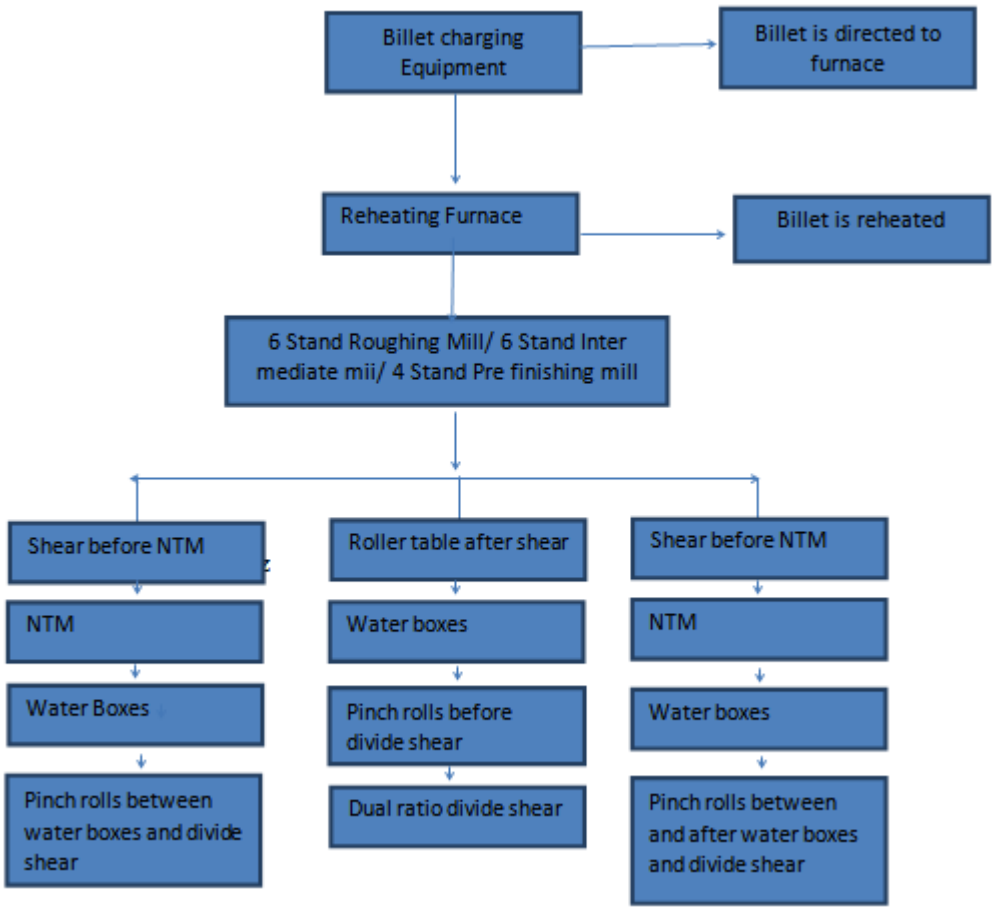

Figure 3.1 Process flow chart of BRM process

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Figure 3.2 Different process of BRM

In the above process no twist mill operation will lead to 12% delay in the production of the product per annum. So this case has been studied by JSW engineers and reduced the delay of 23 min for every 100 min. And the same has been reduced by the below analysis

IV. RESULTS AND DISCUSSION ON IMPROVEMENTS:-

The case study discussed in the chapter 4 can be improved further by another lean tool ie., Six Big Losses

4.1 Introduction:-The Six Big Losses originate from the world of Total Productive Maintenance (TPM). Seiichi Nakajima developed TPM and the Six Big Losses in 1971 at the Japanese Institute of Plant Maintenance

Six Big losses are categorized effectively. Six Big losses are of 6 types –

OVERALL EQUIPMENT EFFECTIVENESS	SIX BIG LOSSES
Availability loss	Unplanned stops
	Planned stops
Performance Loss	Small stops
	Reduced speed
Quality Loss	Production rejects
	Startup rejects
OEE	Fully Production time

Table 4.1 Different types of six big losses

4.2 Six Big Losses and their reduction-
Unplanned Stops are important duration of time in which equipment/operation is scheduled for production but is not running because of an unplanned event.

Examples include breakdowns of equipment, tool failures, unplanned maintenance, operator unavailability or materials,block occurs in the equipment.

Reduction - Machine, equipment maintenance schedule must follow by the relevant department. Train the line operators to do the task of other operators as well in case of any unavoidable situation. This skill is called multitasking workforce.

- Planned Stops are duration of time in which the equipment is scheduled for production but it is not running because of a planned event.

Examples include changeovers, tooling adjustments, cleaning, planned maintenance, and quality inspections. Many companies also categorize breaks and meetings as Planned Stops

Reduction- These are the unavoidable situation during work as these are the part of the process but what we can do, we can minimize the changeover time and time of adjustments after enhancing the work efficiency of the operator.

- Small Stopsare occurred when equipment stops for a short period of time with the stop resolved by the operator.

Reduction-Refresher training for working operators can eliminate these losses during work

- Slow Cyclesare occurred when equipment runs slower than the ideal cycle time ie., standard timing for the equipment.

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Examples include dirty or worn out equipment, poor lubrication, substandard materials, poor environmental conditions, operator inexperience and shutdown.

Reduction - Compliance with the SOP's, PFC's and MQAA (manufacturing for quality assurance audit) can ensure the quality of the product and speed of the manufacturing process. Good environmental conditions ensuring 6S. Refresher training for operators can enhance the speed.

- Production Rejects are defective parts produced during stable production. This includes parts that can be reworked, since OEE measures quality from a First Pass Yield perspective.

Examples include incorrect equipment settings, operator or equipment handling errors, or lot expiration (e.g., pharmaceutical).

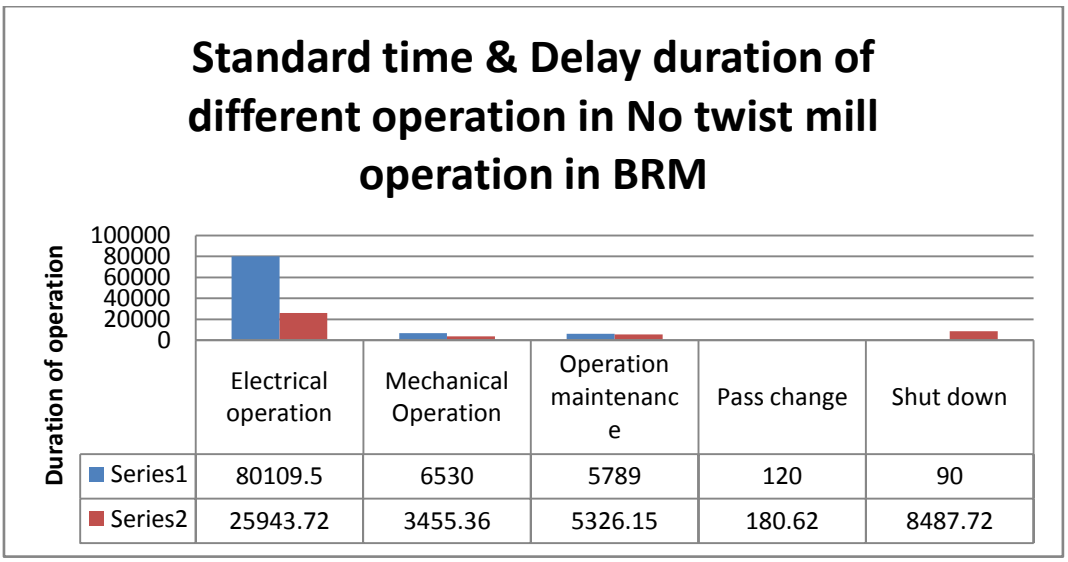
Reduction – Make sure that operators are following the standard of operations, work standards and process flow charts. Only manufacturing for excellence audit can ensure process compliance.

- Startup Rejects are defective parts produced from Startup until stable production is reached. They can occur after any equipment Startup, however, are most commonly tracked after changeovers.

Examples include suboptimal changeovers, equipment that needs "warm up" cycles, or equipment that inherently creates waste after Startup.

Reduction – Make sure that operators are following the standard of operations, work standards and process flow charts. Only manufacturing for excellence audit can ensure process compliance.

5.3.Delay data given for the February 2020 by TQM department:-Delay dataprovided by the JSW analysed of the above losses for no twist mill in BRM 1 –



Graph 4.1 Comparison of the duration of standard timing and delay occurred in different operations of non-twist mill machine

In the chapter 4, the analysis carried out only on pass change only where the time reduced for every100 min of operation, delay of 43 min reduced to 23 min. However, now as the observation in the above chart the delay was happened with compare to standard time of operation is more in electrical and shut down operation. So concentrated on the electrical operation and shut down operation delay reduction.

4.3 Electrical delay & shut down delay analysis

These delays comes under slow cycles

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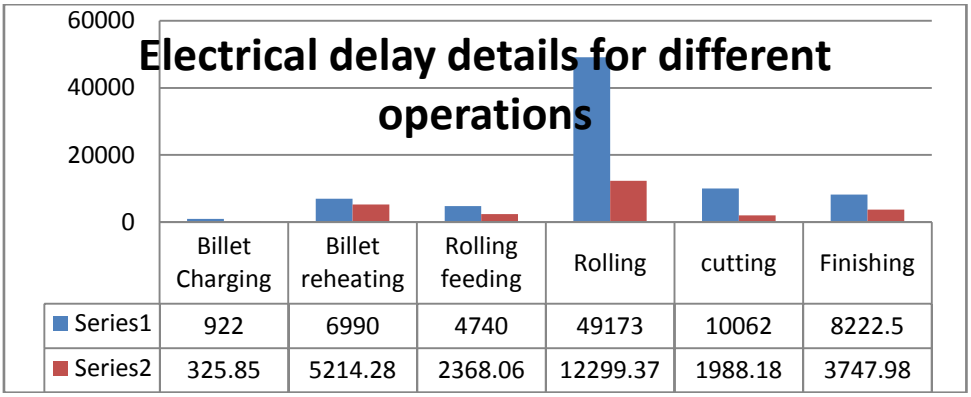
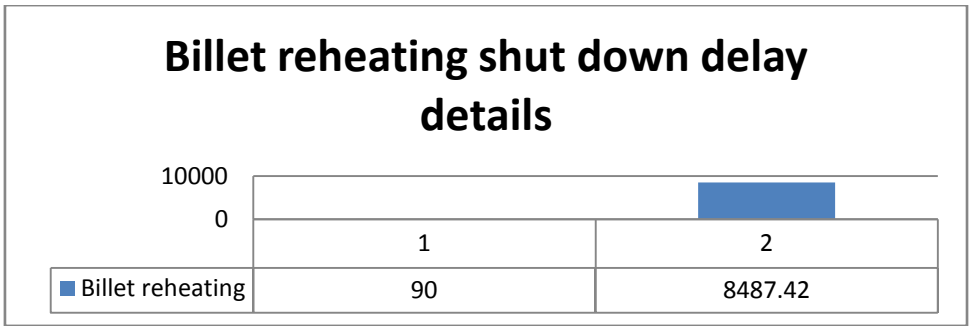
4.3.1 Electrical operations& shut down operations -



Graph 4.2 Bar chart for the comparision of standard time and delay duration in the electrical operations of BRM



Graph 4.3 Bar chart for the comparison of standard time and delay duration in the shut down operations of BRM

From the above details observed that the rolling, billet heating delay are more than the other operations in electrical delay whereas in shut down delay billet reheating delay is more than the standard operation time, hence these operations need to concentrate to reduce the delay.

4.3.2 Reasons &Proper action for the above delay-

The above rolling & billet heating standard time of operation is already mentioned in the standard of operation that means this delay occurred due to many reasons

- Lack of training for engineers, operators and workers
- Lack of monitoring the process
- Identification of problem intime
- Lack of problem solving within the time

4.3.3 Reduction –

- Proper training for engineers, operations and workers by TQM department to make them very familiar about the standard of operation
- Training for the engineers toact for solving the problem in time.
- Problem solving training for the engineers by TQM department
- Setting the goals to reduce the delay
- Monitoring the action plan
- Further improvement brainstorm conducting in the department.

With the above details, we can save the timing of 12239 min & 8487.42 min for the electrical and slow cycles respectively.

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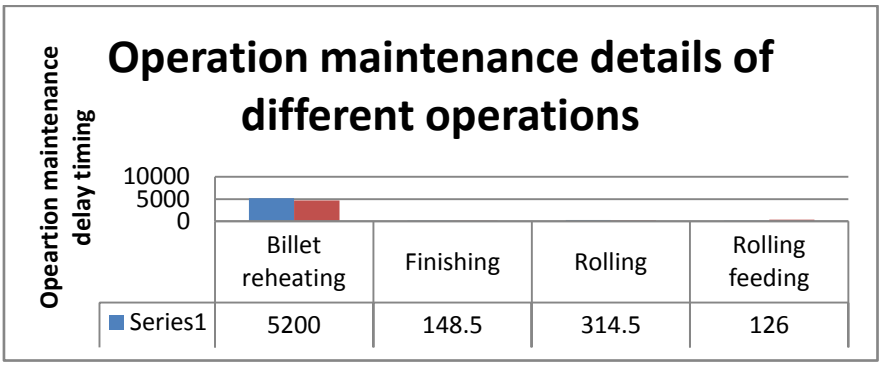
4.4 Operation maintenance delay

4.4.1 Operation maintenance delay will come under planned stops



Graph 4.4 Bar chart for the comparison of the delay details of different operations in the Operator maintenance

In this operation maintenance delay is not avoidable however the time taken for maintenance exceeds the standard timing these need to be reduced.

From the above chart the delay is more in billet reheating and hence the delay reduction to be concentrated more in this operation.

Reasons and proper action-

4.4.2 Reasons-1. Lack of training for maintenance department 2.Even though this operation is part of bar rod mill process standard time need to be maintained.

4.4.3 Reduction-Efficiency of the operator needs to be improved.

With the above we can reduce the delay of operation maintenance by 4686.07 min

Hence for the month we can reduce the delay of electrical, shut down and operation maintenance by 12239 min, 8487.42 min & 4686.07 min with this we came to know for one month data of operations, we can save 17 hours approx. and for the annum we can reduce 211 hours, with this we can improve the productivity

V. CONCLUSION:-

TQM department participation for monitoring the mission and vision of the organization by involving all the management and workers. TQM employees not only concentrating only on the quality of the product it also involves in the quality of cost, time and product which leads to the development of lean in the organization to reduce the delay in the manufacturing ie., waste of time. Lean manufacturing not only reduces the wastes but also involves in the continuous improvement in the standard of process. The data collection from the production department and analysis of the data by using TQM tools like histogram and comparing the planned and deviations timings of different operation in bar rod mill leads to the conclusion how can we can reduce the delays by providing the proper training for employees, workers and labours.

- The data of the equipment captured by the production people in the excel sheet by using videotaping for the process. Microsoft excels helps in sorting different delays like electrical delay, mechanical, shut down, pass change and operator maintenance. And again the same method used in each delay analysis, how the different equipment operation like billet charging, billet reheating, rolling feed, rolling, cutting and finishing are delayed.
- **The below conclusions made by analysing the data provided –**

1. In the annexure II & III- the histogram says that the electrical and shut down delay are more than the other delay ie., the delay duration of electrical and shutdown are of 12239 min & 8487.42 min due to the slow cycles and this time will be saved by giving the awareness to the employees the impact of the delay.
2. In the annexure IV, the operation of shut down timing is more than the SOP and this can be avoided only by the operators.

VI. SCOPE OF THE PROJECT:-

- TQM not only analysing the problems but also giving training by deploying the new problem solving technique like KPI, Kanban, lean and Just In time etc., for the continuous improvement of organization as well as the individuals.

- On implementing the TQM tools like bar charts, pie chart, cause & effect diagram, check list, pareto chart etc., helps to analyse the problems arise in the manufacturing process.
- TQM improving the below activities in the organization for their development-
  - Improving the quality circles to reduce the defects in the process of the organization.
  - Quality circle team development and trained them to use all TQM tools and technologies.
  - ISO implementation not only for quality and for environment, health and safety also
  - Mission and vision of the organization improvement develops for the organization by the TQM.
  - Communication between the organization management and middle level & lower level develops by TQM to provide opportunity to develop the new ideas in the organization.
- Lean manufacturing technology development not only reducing the defects but also reducing the waste of time, money and work.

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