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Management of Spare Part and Reduction of Maintenance Downtime of Resistive Welding Machine

Sagar V. Mahajan, Amit K.Chavan, Prof. M. S. Rohokale

***Abstract*— Central Maintenance (CM) is a way of capturing the potential causes of downtime and poor performance by preventing failures and having a proactive approach to operations and maintenance (O&M).**

Plant operations are responsible for running individual operating tool (eg. spot welding gun, stud welding gun, etc.) while the platform management consists of those responsible for managing specific Spot welding gun type across different regions. Both the plant operations and platform management are responsible for breakdown and maintenance of the operating tools.

Asset-intensive companies face great pressure to reduce operation costs and increase utilization. This scenario often leads to over-stress on critical equipment and its spare parts associated, affecting availability, reliability, and system performance. As these resources impact considerably on financial and operational structures, the opportunity is given by demand for decision-making methods for the management of spare parts processes.[1]

***Index Terms*— Management of spare parts, Maintenance downtime, Reduction of maintenance downtime.**

I. Introduction

Breakdown maintenance is probably the most commonly used approach. When equipment fails, it often leads to downtime in production. In most cases, this is costly business. Breakdown maintenance is carried out on all items where the consequences of failure or wearing out are not significant and the cost of this maintenance is much greater than preventive maintenance.

In the Industry the amount of breakdown was more than the expected level due to which the maintenance worker was not able to perform the preventive maintenance since they remain busy in performing breakdown maintenance work of failed equipment. For this reason the industry was in need of solution which will help to reduce the maintenance time and reduce the cost of inventory by different techniques such as ABC analysis, FSN analysis, Why-Why analysis, etc.

Out of total breakdown in the industry, most of them were from Body shop. Hence we started work from the body shop. In body shop as well we started with equipment wise inspection.

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Sagar Vasant Mahajan, Department of Mechanical Engineering, Sinhgad Institute of Technology, Lonavala, India,

Amit K. Chavan, Department of Mechanical Engineering, Sinhgad Institute of Technology, Lonavala, India,

Prof. M . S . Rohokale, Department of Mechanical Engineering, Sinhgad Institute of Technology, Lonavala, India,

The major aim of the project is to perform the inspection of present scenario, selecting the point of bottom neck for the task of maintenance, working on this area to reduce the cost of spare part inventory and maintenance time.

A. Report of Present Situation:

We have given the area of maintenance to reduce the time. For this we started with investigation of present situation. We firstly had a brief review of how various operations takes place at different location in the company and equipment used for these operations.

In body shop there are total 476 locations or tact where all the operations take place. Tact is the place where the operations are predefined to the worker and these operations are needed to be completed at that tact position itself. In body shop most of the operation are of welding which are performed with the help of Resistive Spot welding gun, Arc welding machine, MIG, MAG, etc. Body shop is one of the most complex locations in the company since entire body of a car is made here.

In assembly shop all the mountings and accessories are fixed on the body. It is less complex then the body shop. Here the car takes its original look of four wheeler vehicle from a body of sheet metal.

While moving through the industry, we observed the entire machine and simultaneously the breakdown of equipment. Specifically major downtime was taking place in body shop. In body shop there are total 436 Quantities of Resistive Spot welding guns are present. Each gun has unique positions of spot weld on car's body. There are Robots as well where these operations can be performed faster than workers to increase production rate.

Resistive Spot welding guns are the major equipment of the body shop and if there is any failure or breakdown takes place then it leads to production loss which is costly. If the failures are minor than there are rectified on site. Whereas if the problem is major then the gun is dismantled to the maintenance shop and other spare gun is used. Some time there is situation that the spare gun is already occupied and the failed gun need to be repaired at that point as soon as possible. At that time the maintenance worker is have to perform the repair operation on site.

When these repair operation was observed by us, we saw that there are difficulties face by the maintenance worker because of which they were not able to perform the task effectively. They use to have more free time since more time was used for getting the exact part no from failed part, searching the parts in store, if there is any modification in the part then again cross checking it with the vendor's data, etc.

B. Objectives:

Various drawbacks were observed in the maintenances operation which leads us to proceed with this project they are as follows:

- Store Department
  - BOM of all the Guns was not available.
  - Location of all the spares in store was not defined so search time required is large for small parts as well.
  - Due to lack of information to get the part no. also added time for search.

- Worker
  - Time consumed by worker to locate exact position of breakdown.
  - Time consumed to note part no. of faulty spare after getting the problem.
  - Time for searching of spare in store room.
  - If spare part no is not found then worker search the part no. from drawing.

II. LITERATURE SURVEY

When production equipment fails or is overhauled, the costs that the company pays may be classified in two categories. In a first category, we consider the intervention costs, which include labor and materials. In the second category, we include downtime costs, which consist of the cost of lost production as well as other consequential costs, such as reconfiguring alternative production lines, using less efficient methods, reduced product quality, lost raw material, and so on .[1]

Pham and Wang [2] review the literature on imperfect maintenance. They classified maintenance works according to the degree to which the operating condition of an item is restored by maintenance as: (a) perfect maintenance:- the system is restored to an operating condition as good as new and has the same lifetime distribution and failure rate function as a brand new one; (b) minimal maintenance: the system is restored but the failure rate is the same rate it had just prior to the failure; (c) imperfect maintenance: the system is not as good as new, but younger than it was at failure time; (d) worse maintenance: the system failure rateor actual age increases but the system does not breakdown. As a result, the operating condition becomes worsethan that just prior to the intervention; (e) worstmaintenance: a maintenance action which undeliberately makes the system fail. [2]

Quantifying intervention costs is quite straightforward since standard accounting procedures register them. On the other hand, downtime costs may be hard to estimate because they depend on several external factors like production rates, stock prices, and system design parameters (redundant equipment, stock piles, and alternative production methods). The sum of both intervention and downtime costs define the global cost, which is a very interesting indicator to measure the success of maintenance management strategies [3].

To minimize intervention costs: once availability is modeled, it is direct to estimate intervention costs and to fix a budget. This criterion does not take explicitly into account downtime costs. In order to this, it is necessary to add a minimum availability constraint explicitly. This would be achieved imposing a minimum availability constraint. [4, 5,6]

Spare parts play a fundamental role in the support of critical equipment. In a typical company, approximately one third of all assets correspond to inventories. Of these assets, critical spare parts have special relevance because they are associated with both significant investment and high reliability requirements. As an example, spares inventories sum up above US $50 billion in the airlines business. [7, 8.]

The mismanagement of spare parts that support critical equipment conduces to considerable impacts on financial structure and severe consequences on operational continuity. The improvement of key profits on both logistics and maintenance performance can be achieved by inventory management of costly components, which have extremely criticality on equipment-intensive industries. [11]

Lead time is another important aspect to consider in spare parts ordering. The random time between fault event and the actual component failure may cause system performance deteriorations. [9]

This situation is even more crucial when spare parts are critical, since they are not always available at the supplier store. Customs delays and the need of special transport are a source of significant lead times; moreover, when dealing with complex equipment parts made to order, lead times may exceed a year.[10]

Maintenance activities and production are always in disagreement. Maintenance activities bring the production to a halt and delay it until the production sequence leads to an increase in the probability of machines failure and level of degradation. During the scheduling, it is usually assumed that the machine is available during the planning horizon but this simple assumption may not hold for many real-world applications. Recently, central maintenance (CM) or condition based maintenance (CBM) policies are growing in popularity in industrial environments. Many of these policies apply to decrease the cost of maintenance activities which are the largest part of any operational budget, so CBM is extensively used in production environment. [12]

The processing models of jobs are divided into two main categories in flow shops with unavailability constraint of machines: ‘‘resemble” and ‘‘non-resemble”. For the first one, when the maintenance period interrupts the processing of a job, the operations can continue with no penalty until the maintenance is completed. However, there is a penalty for the non-resumable case and the whole processing operations on the unavailable machine need to be restarted. [13]

We have studied from this paper, the two production control policies that deal with stochastic machine breakdowns. The first one assumes that the production of the interrupted lot is not resumed (called no resumption or NR policy) after a breakdown. The second policy considers that the production of the interrupted lot will be immediately resumed (called abort/resume or AR policy) after the breakdown is fixed and if the current on-hand inventory is below a certain threshold level. In their article, both policies assume the repair time is negligible and they studied the effects of machine breakdowns and corrective maintenance on economic lot size decisions. Since, studies have been carried out to address the issue of production systems with breakdown. [14]

III. METHOLOGY

A. Inventory Management:

Inventories constitute the most significant part of current assets of a large majority of companies. A considerable amount of funds is required to maintain the large size of inventories. It is therefore absolutely necessary to manage inventories efficiently in order to avoid unnecessary investment and the companies have to reduce the level of its inventories to a considerable level without any adverse effects on production and sales, by using simple inventory planning and control techniques.[17]

a) *FSN analysis:*

F-S-N Analysis: Criterion employed: Rate of consumption of items in terms of rate of their issue from stores.

In F-S-N analysis, items are classified according to their rate of consumption. The items are classified broadly into three groups: F – means Fast moving, S – means Slow moving, N – means Non-moving. The FSN analysis is conducted generally on the following basis:

- The last date of receipt of the items or the last date of the issue of items, whichever is later, is taken into account.
- The time period is usually calculated in terms of months or number of days and it pertains to the time elapsed seems the last movement was recorded.

FSN analysis helps a company in identification of the following

a) The items to be considered to be "active" may be reviewed regularly on more frequent basis.

b) Items whose stocks at hand are higher as compared to their rates of consumption.

c) Non-moving items whose consumption is "nil" or almost in significant.

b) VED ANALYSIS:

This analysis specially pertains to the classification of maintenance spares denoting the essentiality of stocking spares according to their criticality.
V - Stands for vital – items when out of stock or when not readily available, completely brings the production to a halt.
E - Is for Essential items without which temporary losses of production or dislocation of production work occurs.
D - Denotes Desirable items – all other items which are necessary but do not cause any immediate effect on production.

c) *Ishikawa Diagram*

Common uses of the Ishikawa diagram are product design and quality defect prevention, to identify potential factors causing an overall effect. Each cause or reason for imperfection is a source of variation. Causes are usually grouped into major categories to identify these sources of variation. The categories typically include:

- People: Anyone involved with the process
- Methods: How the process is performed and the specific requirements for doing it, such as policies, procedures, rules, regulations and laws
- Machines: Any equipment, computers, tools, etc. required to accomplish the job
- Materials: Raw materials, parts, pens, paper, etc. used to produce the final product
- Measurements: Data generated from the process that are used to evaluate its quality
- Environment: The conditions, such as location, time, temperature, and culture in which the process operates

III. IV. EXPERIMENT &RESULT

A. Ishikawa Diagram

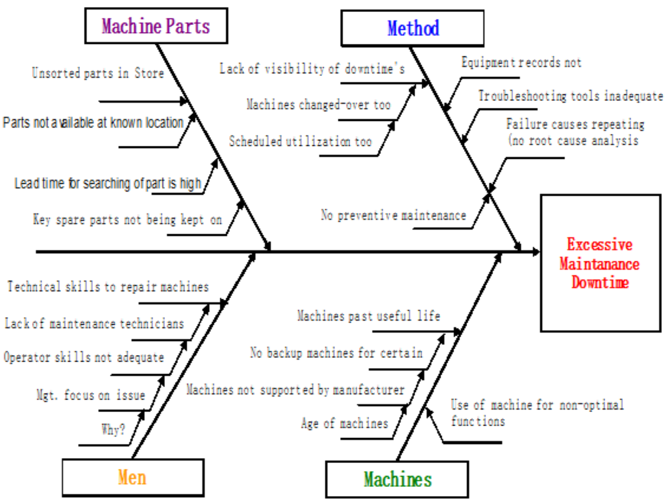

Fig 2. Fishbone Diagram

B. Time Value Analysis

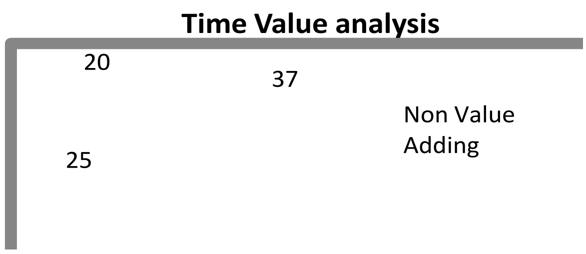

Fig 1. Time values analysis

Distribution of Activities in following :-

- Non Valuing Adding Activities
  - Searching of Spare Parts in store.
  - Locating Breakdown position.

- Non Value Adding but Essential Activities
  - Noting part no. of spare.
  - If not found on faulty spare, then searching in drawing of the vendor.

- Value Adding Activities
  - Problem Searching and deducing the faulty part.
  - Changing the part and rectifying the problem.

Cause	Solution
Man (People)	
- Problems created due to lack of communication	- Proper information flow should be designed
- Lack of Technical Skills	- Need of training
- Absence of work pattern while performing maintenance.	- Work pattern should be determined
Machine Parts	
- Unsorted Parts in store	- Arranging the parts using some techniques
- Parts not available at designatedlocation	
- Lead time for searching is high	
- Key spare parts are not being kept on hand	
Machine	
- Machine past useful life	- Machine past useful life
- No backup machine available	- No backup machine available
- Machine spare not available from manufacturer	- Machine spare not available from manufacturer
- Cable gets damaged regularly	- Cable gets damaged regularly
Method	
- Lack of visibility of Downtime effect	- Lack of visibility of Downtime effect
- Machine change over two often	- Machine change over two often
- No preventive maintenance performed	- No preventive maintenance performed
- Equipment records not maintained properly	- Equipment records not maintained properly

Table 1.showing the Cause and Solution.

C. . Areas of Improvements:

Area	Problem	Solution
Store Department	- Searching time is more - Lack of information about the spare location. - Available spare list is also out-dated	- Using FSN technique the store should be arranged such that the required part can be located in minimum time.
Worker	- Lack of communication - Lack of information regarding equipment and spares details	- Proper information broacher can be designed to full the information need.

Table 2. Showing the Areas of Improvement

D. Result Implementation of FSN Technique in Store department:

We modified the layout of the Store department according to the results deduce from different analysis. Specially emphasising on the FSN analysis the store was modified as section of fast moving , Slow moving and Non-moving.

Fig 3.Layout of Store Room

The Fast moving materials are kept on the section in Green in layout to keep the material in close reach of store person. So as he should be able to provide the material as soon as the requirement is filled. And keeping a check on the quantity of material present. So if ordering of material is required it can be ordered.

The slow moving materials are the one which are issued once in a year or more. So they are kept at some distance as they are not consumed more. They are kept in the section with yellow colour in the layout. Since the no of slow moving material will be more than the Fast moving material.

The non-moving material are kept at one corner of the store department as they are rarely used material, they are issued once with the period of 3 years or more. They are kept in the area with red color in the layout.

Fig 4. Showing the View of Store Before Rearranging

Fig 5. Showing the View of Store After Rearranging

IV. DESIGN OF HAND BOOK

A. Pre-requisite Data for Hand Book

- List of Equipment on Location and Sub location wise.
- Spare list for each equipment.
- Data of Spare list with SAP no and Part no.
- Equipment wise drawing.
- Spare location for each spare in storewith SAP no and Part no.

B. Layout design of Hand Book

It was expected from the word "Hand Book" that it will be hand held which will not be bulky.Since if the book becomes bulky the worker may feel lazy to carry this book with him. So we have to try to accommodate all the DATA collected into this book keeping it compact.

Primary motto to design the Hand Book was to connect the following DATA:

Fig 6.Showing the Dependency of DATA for tracking.

The Final layout which confirmed was such that it was able to accommodate all the data which would help to reduce the downtime. The format of the layout can be seen on next page. It was so design that the tractability of the equipment is twice. Firstly, the location wise

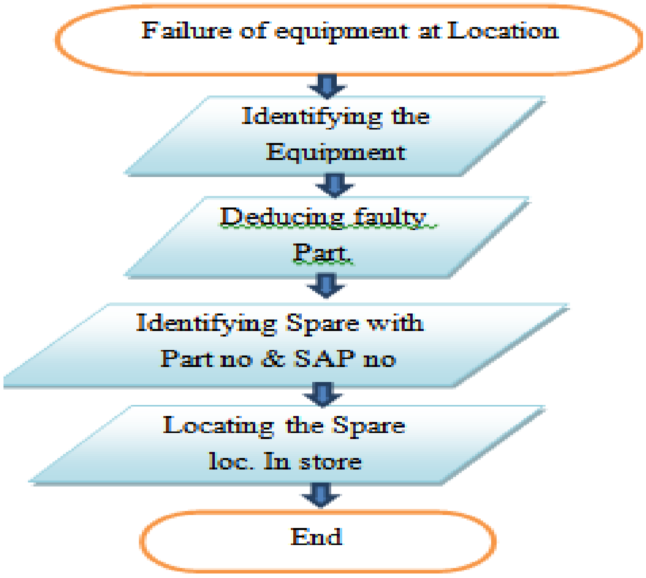

Fig 7.1st Type of Approach

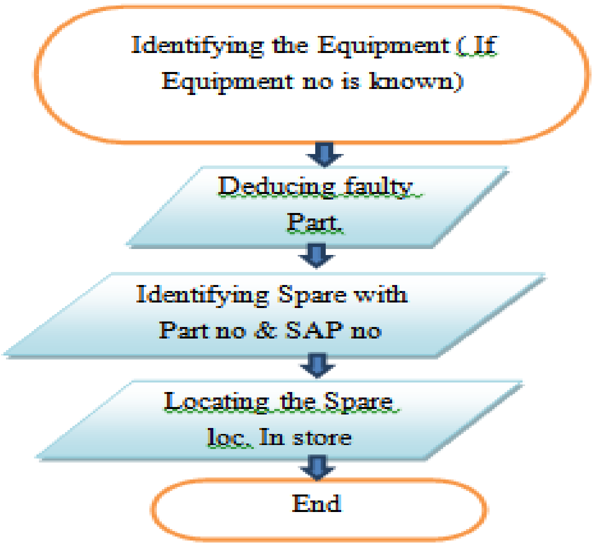

Fig 8.2nd Type of Approach

V. VEXPERIMENTATION RESULTS

From the chat we come to know that time consumed before was more than the experimental result. Because of rearrangement of inventory spares, the major consumption of time had gone down in the searching of part.

The information layout in the catalogue has really helped the worker as we can see that there is minor decrease in the time consumed for searching of location and , Deducing the fault and nothing part no. has come down.

Because of this reason the overall time consumption which was about 84minsearlier is only 62 min now. Which show the reduction of 22mins in repair time which is equivalent to the production of 11cars.

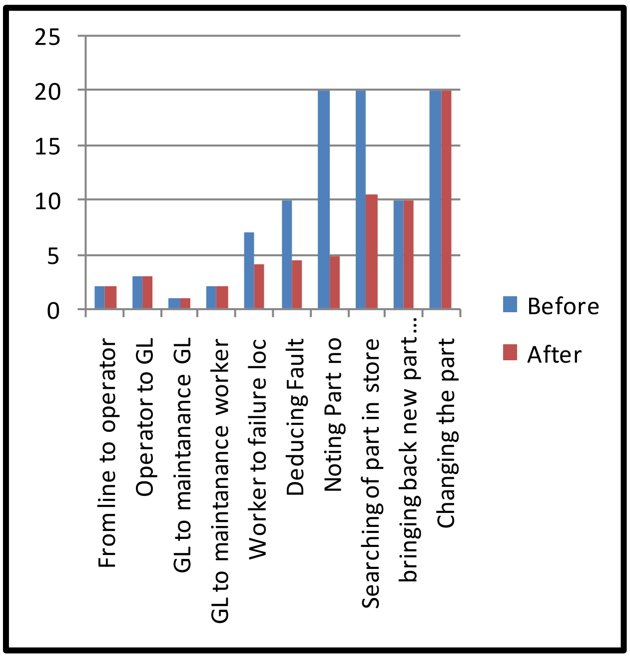

Fig 9. Showing the Chart Comparing the time Before and After the Application of Handbook

VI. CONCLUSION & SUMMARY:-

From the analysis of our project we reduced the maintenance breakdown time in the body shop of the company. The major work area is between the maintenance workers going to the failure location for checking the machine, bringing new part to the location, searching the part in Store. The time during the maintenance worker going to breakdown location is reduce by providing user manual to maintenance group leader and also to the leader of line work. So by using Handbook they are getting easily location of breakdown and part which is to be replaced within the minimum time. So the work efficiency increases. Time reduce by our efforts of Handbook is near about 22 minutes which is equivalent to 11 cars of production.

So that our project is beneficial for company which reduced breakdown and maintenance time. It will give more production and increase efficiency of plant after implementing our Handbook.

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Sagar V. Mahajan is a student in Department of Mechanical Engineering, Sinhgad Institute of Technology, Lonavala, India.affiliated to Pune University. He is in final year of Mechanical Engineering. He is currently working on reduction of time in Maintenance Department.

Amit K. Chavan is a student in Department of Mechanical Engineering, Sinhgad Institute of Technology, Lonavala, India.affiliated to Pune University. He is in final year of Mechanical Engineering. He is currently working on reduction of time in Maintenance Department.

Prof. M. S. Rohokale is HOD in Sinhgad Institute of Technology, Lonavala. He is pursing Ph.D.(Mechanical Engg.)at Singhania University, PacheriBeri , Jhunjhunu, Rajasthan from 01-01-2011 on “Analytical study on Optimization of Mechanical Energy: An Environmental Utilization Perspective.” Master Of Technology in “Production Engineering” (M.Tech.Production) from Poojya Dodappa Appa College of Engg. Gulbarga Karnataka, from Visveswaraiah Technological University,Belgaum , Karnataka, India in Nov. 2001with First class in Distinction. Master of Business Administrationwith Material Management(M.B.A.) from PIRENCE, Pravaranagar, from Pune University in April 1999 with first class. Batchelor of Engineering(B.E)from AVCOE, Sangamner, from Pune University in April 1997 with first class.