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Research Article

# MODELING OF PART REPLACEMENT PROBLEM IN HYDRAULIC PACK BY DECISION MAKING: A STUDY

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**A R T I C L E I N F O**

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**A B S T R A C T**

Maintenance is required to keep the facilities and equipment in good working condition so that it can deliver better performance without causing any loss of time. A collective measures taken up by the industry in order to keep the equipment or machine in trouble free environment or in good environment is called maintenance engineering. In this Paper, we discuss on the Operation Research techniques which can play the vital role for reduce the Machine breakdown. Operation research techniques may help for proper Maintenance planning, Scheduling of preventive maintenance & Spare parts planning.



## INTRODUCTION

Maintenance is an activity in order to achieve better quality, reliability and efficient working. Maintenance can be divided into two groups (a) Breakdown maintenance (b) Planned maintenance. Operational availability of the machines is taken care by the maintenance department. The concept of maintenance was very old and no proper care was given to the machines. When machines stopped, these machines were discarded or repaired. (Christer J. Whitelaw, 1983) [1] Evaluated an O.R. ap-proach designed to assist management in the task of identifying and subsequently quantifying potential areas for improvement in the e_ectiveness of maintenance.

The study establishes that focused TPM implementation over a reasonable time period can strategically contribute towards realization of signi_cant manufacturing performance enhancements. Maintenance Worker scheduling modal is presented by (Gupta, Ali, A.Ahmad) [2]. The study has proposed SAI-Method for solving se-quencing problems. The procedure adopted for solving the wide range of sequencing problems is easiest and involves the minimum numbers of iterations to obtain the sequence of jobs. Overall e_ciency of a Printing machine is described by (Kumar, Shetty, L.R rodrigue, Feb.2014) [3]. Total productive maintenance establishes a system of productive maintenance, covering the entire life cycle of equipment, cov-ers all departments, involves participation of all employees from top to bottom and promotes small group autonomous activities.

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During high growth era companies make technical progress in automation and centralization of the plants, which needs large amount of manual work to maintain the automation systems. The strategy of maintaining the equipment of a plant is crucial for the effectiveness of manufacturing. To carry out successful implementation of our work, firstly, literature review was done thoroughly to understand the underlying concepts of TPM. Further, empirical study was conducted based on real time data and analysis was done to obtain achievable results. Finally questionnaires were distributed to assess information on successful implementation of TPM in the industry. A comparative study between World Class industries where TPM has been implemented and industries which do not follow TPM identies the various problems leading to decrease in the overall Efficiency of the industry and provides valuable suggestions focusing on the benefits and methodology for implementing TPM in industries. (Sharma Shay G, Shrimali Sapna, Aug.2017) [4] studied the role of Operations Research techniques for designing a Material Handling model which will help to increase the productivity and reduce cost. This paper presents the way to select the path and route of vehicles for safe and low cost in industries and improve the productivity. (S.Kotle A. Dabade, 2017) [5] Improved the Availability of a machine by implementing effective Preventive maintenance. The function of automated machines is to achieve higher production rate with better quality. Therefore machines must remain in operating condition in order to achieve the desired result or goal. The failures or breakdown of machines cause disruptions in production resulting in a loss of availability of the existing system. This further increases the cost of maintenance. Because of this, to

face a greater competition in the market, industrial engineers always try to improve productivity continuously. One way to increase the productivity is to increase the operational availability of existing machines. This paper highlights recent research work carried out and a case study conducted in leading automobile industry with results obtained to increase machines operational availability or up time by implementing effective preventive maintenance schedule. (Kiran, Mathew, Jacob, Jan 2013)[6] Presented the Root cause Analysis effect on the machine breakdown. With the help of this analysis can be identify the main reason of failure. So this cause may be eliminate and avoid the breakdown in future. Analysis of Breakdown in Hydraulic Machine is done by (Kumar R Rudramurthy, Aug. 2013) [7]. The main objective of the project is to increase the availability a machine and to reduce the down time of a machine, to maximize production capacity and to improve new Preventive maintenance schedule. The project is carried out on hydraulic press were all repeated breakdowns analyzed along with the critical parts, which were under breakdown condition is also identified and analyzed . Proper planning of work leads to the better productivity of machine. (Shagluf, A.P, S.Fletcher) [8] Studied the maintenance strategies to reduce downtime of machine. In this study they found the position effect of machine in breakdown. Manufacturing strives to reduce waste and increase Overall Equipment Effectiveness (OEE).(Sharma Shay G, Shrimali Sapna, Aug.2017) [9] studied the role of Operations Research techniques for made a job assignment model which help to increase the labor productivity and cost reduction with respect to time. The paper present that the groups for execute the work in industries can done the job with different efficiency which affects the ma-chine running time. In paper we show the practical issues and rectify these types of problem with the enhancement of skills of man power Key words and phrases. Maintenance, Productivity, Manufacture, Replacement, Scheduling.

***Preliminaries***

Let the time for machine A, B, C D are Xi, Yi, Zi Wi respectively. But for the scheduling machine A stop for _G time. This machine can provide to maintenance department for a specific task according to criticality of job by operation team to maintenance team. So for recover the daily production target has to increase the running time of other machines. We can call the increase running time of machine as recovery time of production. Let ΔYi, ΔWi & ΔZi are the increase running time of machines if machine A provide for the maintenance. So it can be describe

Xi + Yi + Zi = G

Where G=Total running time of all machines in a day. If Xi machine stopped for ΔG time. So the all machines have the efficient increase running time equal to ΔG . So can be conclude

ΔX + ΔY + ΔZ = G

The recovery time can be divide in all three machines equally? So can be consider

ΔX = ΔY = ΔZ

consider when the Xi machine given to maintenance for G time and increase the running time of remaining machines accordingly. Then can write the equation

(Xi + ΔG) + (Yi +ΔG/3) + (Zi +ΔG/3) + (Wi +ΔW/3) =G

(Xi + ΔG) + (Yi + Zi +Wi) + ΔG = G

This is Right side of equation 2.1.This is the total running time of all machines which achieved the production level of this day. This time period is very crucial for the maintenance team because after the maintenance not acceptable by management any type of breakdown in this machine. So there is requiring a decision to maintenance manager to replace the part or repair it. The failure analysis this is a major step to change or replace the part of machine. Part can be replace if the life of part completed but the life of the part not completed and failure in machine continuously. Then the cost of the part maintenance can calculate mathematically which help to take decision that the part replacement is more suitable than repair. It is difficult for manager to part or component should be change.

The replacement problem arises due to these factors:- 1. If the old item has failed to perform due to worse condition. 2. The old item has failed to accident and does not work properly. 3. Better or More efficient design of machine. In the gradual failure the operation expenditure increased continuously. And the value of equipment decrease. In other hand sudden failure is increased with the service life. It may be accidently and the big loss in term of production. In same way random failure occurred due to any physical shock. So failure analysis helps to take decision to replace the equipment or repair. Now we take the case when the time is continuous variable and the cost of part change according to time. The cost of repair the part at time t is Ct and the average cost of part till time n is Cn.

$$C_t = \left(\frac{1}{n}\right)\int C_t\,\delta t + (\,C - S)$$

Where Ct = Repair cost, C=Capital Cost, S=Scrap Cost

(a) When time t is a continuous variable and the cost of part changing accordingly to time. Let consider the time is varying 0 to n. The cost of repair the part at time t is Ct and the average cost of part till time n is Cn. Now arise the another condition that the depreciation price of the material is not according to time. The time is discrete function So time t is discrete variable and the cost of part not be change accordingly time.

$$F(n) = \frac{P(n)}{n} = \sum[\frac{C_t}{n} + \frac{(C-S)}{n}]$$

By following this the difference between the two consecutive cost are minimum So the cost F(n) and F(n-1) difference should be minimum, we obtain.

$$\Delta F_n = F_n - F_{n-1}$$

$$\Delta F_n = \sum(\frac{C_t}{n+1} + \frac{C-s}{(n+1)}) - \sum(\frac{C_t}{n} + \frac{C-S}{n+1})$$

Since for the minimum cost increase the Δ F(n) should be minimum So it can be conclude

$$\frac{C_{n+1}}{n+1} \geq \sum(\frac{C_t}{n+1} + \frac{C-s}{n(n+1)})$$

$$C_{n+1} \geq \sum(\frac{C_t}{n} + \frac{C-s}{n})$$

$$C_{n+1} \geq \sum\frac{P(n)}{n}$$

Now there are arise two cases.

If time is measure continuously then the average annual cost will be minimized by replacing the machine when the average cost to date becomes equal to the current maintenance cost.

If time is measured in discrete units, then the average annual cost will be minimize by replacing the machine when the next period maintenance cost becomes greater than the current average cost. Now discuss the Hydraulic pump of filter presses. The cost of the pump 6100 Rs and the maintenance cost of the pump estimated change to each month. According to the time the maintenance cost increased slightly in each month basis. The life of this pump is one year so it is better to choose the replacement policy for the pump in aspect of repair. Due to this team have the interest to replace the pump after optimize use so the cost not be higher than repair cost initially 100 Rs in first month. After this second year the cost may be increase 250 Rs gradually. After damage in pump there is no utilization and throw in the scrap. So gradually with time the cost of maintain this equipment will increase and this is very difficult to survive with this equipment. In this case required a system which support to take decision that the equipment repairment or replace at this moment.

Total cost in one month = maintenance cost of 1st month + loss in purchase price

$$= 100 + (6100 + 100) = 6100\text{Rs:}$$

So average cost in first year=6100 Rs.
Total cost up to two month = Maintenance up to two month + loss in purchase

Price = (100 + 250) + 6000 = 6350Rs

Average cost per month during first two month

$$= \frac{6350}{2}$$

3175 Rs:

In similarly average cost per year during first three month =

$$\frac{100+250+400+6100-100}{3} = 2250 \text{ Rs}$$

In similarly average cost per year during first fourth month

$$= \frac{100+250+400+600+6100\ \ 100}{4}$$

$$= 1837 \text{ Rs}$$

In similarly average cost per year during first fifth month =

$$\frac{100+250+400+600+900+6100\ \ 100}{5} = 1650 \text{ Rs}$$

In similarly average cost per year during _rst sixth month

$$= \frac{3850+6100\ \ 100}{6} = 1583 \text{ Rs}$$

In similarly average cost per year during _rst seven month

$$= \frac{9500+1600}{7}$$

$$= 1585 \text{ Rs}$$

| Replace at the end of month | Maintenance cost Cn | Cumulative mainte-nance cost | Difference between price and Resale (C-S) | Total cost P(n) | Average cost Pn n |
|---|---|---|---|---|---|
| (1) | 2 | (3) | (4) | 5=(3+4) | 6 |
| (1) | 100 | 100 | 6000 | 6100 | 6100 |
| (2) | 250 | 350 | 6000 | 6350 | 3175 |
| (3) | 400 | 750 | 6000 | 6750 | 2250 |
| (4) | 600 | 1350 | 6000 | 7350 | 1837 |
| (5) | 900 | 2250 | 6000 | 8250 | 1650 |
| (6) | 1250 | 3500 | 6000 | 9500 | 1583 |
| (7) | 1600 | 5100 | 6000 | 11100 | 1536 |
| (8) | 2000 | 7100 | 6000 | 13100 | 1638 |

By the table it is easy to analyze that the cost of maintenance is increasing gradually each month but it is less than the average cost on starting month. Till the starting month of installation the gap between the maintenance cost and average cost of machine is large but after few month the gap is reduced. And at seventh month the cost of maintenance is higher than the average cost. So if the team is continue with the same pump there will be increase the maintenance cost continuously and the average cost will near to maintenance cost.

## CONCLUSION

The reliability of the machine can be improve with the proper planning of replacement. In this paper we found that the repair of the machine will become costly after sometimes. This is essential for a good planner to replace it before the cost of sustain the equipment increase. This paper conclude the role of Operations research in machine maintenance system.

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