

Adoption of Maintenance Strategy for Plant Assets

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Abstract— The maintenance strategy adoption for plant assets is crucial decision. Selection of proper maintenance strategy for plants assets is difficult because of its suitability, limitations and the cost of maintenance. The different maintenance strategies are discussed in this paper. Each particular maintenance strategy has its own benefits and limitations. The aim of this research is provide an easy and concise chart for the adoption of maintenance strategies. The maintenance strategy can be adopted on the basis of 'maintenance strategy adoption chart' that is constructed with suitability, limitations and benefits of maintenance strategy.

Key words: Maintenance, Maintenance Strategy, Machine, Adoption, Plant Asset

I. INTRODUCTION

Running the plant machinery problem free is necessary for production and this is done only when the adopted maintenance strategy for particular machine is suitable to run that machine at specified performance. Adoption of maintenance strategy is necessary to run the machine at its specified parameters, improve the availability, quality of products, safety of operator and at optimal cost of maintenance [1]. The maintenance managers have to adopt best maintenance strategy from several maintenance strategies for each element of machine or system [2]. Many researchers have reported about the maintenance cost; Bevilacqua and Braglia (2000) reported that cost of maintenance lie between 15% to 70% of total production cost [2]; Komonen (2002) and Simoes et al. (2011) reported in his study that the maintenance cost are near about 25% of the overall operating costs for manufacturing firm [3, 4]; Salonen and Deleryd (2011) presented that cost of maintenance near about 30% are associated to purposeless expenditures because bad planning, overtime and unsystematic preventive maintenance [5]. Choosing a best strategy or combination of maintenance strategies for particular machine depends on so many parameters like: availability of maintenance budget, criticalness of machine failure, safety of operator as well as machine, affect of machine failure on production and associated production loss. Now, it is clear that design of maintenance program in such way that it must be optimal and give the best results.

II. MAINTENANCE STRATEGIES

There are so many maintenance strategies, which are adopted for maintenance purpose of equipments or machines. Basically two types of maintenance strategies: planned maintenance and unplanned maintenance [6].

A. Unplanned Maintenance

As the name indicate that there is no planning for maintenance. The maintenance of equipments or machines does either on the random basis or after the breakdown.

- 1) **Corrective Maintenance:** This type of maintenance performed when machine deviate from its intended function then corrective measures taken to rectify the problem.
- 2) **Breakdown Maintenance:** This is also known as Run-to-Failure maintenance. The maintenance action taken only when machine component has failed. This is most suitable where the minimum loss due to breakdown as well as the failure is not hazardous.
- 3) **Emergency Maintenance:** Emergency maintenance is considered as unplanned maintenance. Emergency maintenance adopted where the failure of machine components or system can result in loss of man and money. To avoid serious and hazardous problem an emergency maintenance action are taken.

B. Planned Maintenance

The planned maintenance category, in which the maintenance activities are planned either time basis or condition basis. The time basis planned maintenance either regular or schedule. The condition based maintenance activities depends upon the condition of machine components.

1) Routine (planned) Maintenance:

Maintenance activities for machine or system is properly planned as per the requirement of the system and these requirement is identified through the past failure data and experiences. The maintenance activities are done on cyclic basis.

2) Preventive Maintenance:

It is type of maintenance, which enables some specific tasks and designed in such manner to prevent the need of corrective and breakdown maintenance, also prolong the life span of equipments [7]. There are basically three types of preventive maintenance: scheduled/fixed time maintenance, condition based maintenance and reliability-based preventive maintenance.

Scheduled / fixed time maintenance is work on preventive approach and the equipment care has taken either through well prepare schedule or simply time basis for plant machinery.

Condition based preventive maintenance in which the repair or replacement of machine components or system is done on their condition. The condition of machine components or system is identified using some inspection techniques.

Reliability-based preventive maintenance preferred where the reliability of system is concern. It always

preferred where the chances of catastrophic failure. The aims behind this maintenance prevent failure and prolong the life-span of plant assets [7].

3) *Predictive Maintenance:*

This philosophy of maintenance predicts the failure trend of machine elements on the basis of monitored trend it is easy to forecast the failure of machine element. On the basis of forecast the maintenance decision is made whether the repairing or replacement. Continuous monitoring or diagnostics techniques are used for forecasting of failure trend or condition of equipment [8]. The condition monitoring technique gives the real time performance and signature trend of machine with the help of sensors and data acquisition system.

4) *Proactive Maintenance:*

This principle of this strategy is to involve each and everyone for asset care. The care of asset is not only responsibility of maintenance personal. Through proactive approach reliability, maintainability, and operability can improve. This strategy also has positive impact on firm's productivity and profitability [8].

C. *Other Strategies*

1) *Reliability Centred Maintenance*

This strategy is mainly concern on reliability of assets. Reliability of assets is concern due to catastrophic failure. The maintenance of machine or machine components is done on the basis of past data of failed components. The conditions and causes of failure are identified through the failure analysis techniques. To apply RCM on the machine, firstly the critical components of machine are identified.

Then the repair and replacement is done of these critical components to ensure the reliability of the system [1, 9, 10].

2) *Total Productive Maintenance:*

Three words of TPM have their own meaning; Total means each & every employee, Productive means maintenance can be done during operation and make trouble free production, Maintenance means production operator has actively involved for asset care [11]. TPM works on proactive approach as well as cost-effective because of it, the overall equipment effectiveness increases [12]. TPM is not only for single machine or assembly; this is organizational strategy to involve all employees from top management to shop floor workers to keep assets functions on its specified level [13].

3) *Computer Maintenance Management System:*

This is integrated system contain data files and many sets of computer programs that manage the large amount of data related to maintenance and inventory control and provide the necessary details whenever required to user with a cost effective manner. This provide necessary details about maintenance as well as scheduling alerts to concern person, it means it manage the human resources as well as capital resources of plants. It overcome the manual maintenance related deficiencies and improve machine performance also increase life span of machine [7].

III. ADOPTION OF MAINTENANCE STRATEGY

Adoption of proper maintenance strategy for plant asset is very essential. The best suitable strategy run the machine at defined level of performance as well as optimal. To adopt maintenance strategies refer table-1.

Maintenance Strategy	Suitability	Limitations	Benefits
Corrective Maintenance	Suitable where the no hazard and very less production loss.	Do not apply for hazardous and harmful failures.	Deviated machine performance again at specified level.
Breakdown Maintenance	Breakdown of component do not affect the whole machine and workers. e.g. electrical motor winding. Apply where no catastrophic failure and repair time is less.	Not suitable where more production loss. Cost of breakdown (replacement) maintenance must be less than cost of other maintenance.	Repair or replacement when components break. No other attentions require.
Emergency Maintenance	Suitable where sudden failure occurs.	Do not apply for hazardous and heavy loss. Risk is high.	-----
Routine Maintenance	Routine care of assets requires.	Routine care. Reliable past data require.	Prevent failure. Smooth functioning.
Fixed time or Scheduled maintenance	Operates machines in good performance. Try to avoid failures.	Proper scheduling is required.	Reduce failure and breakdowns. Reduce costly downtime.
Condition based preventive maintenance	Suitable for critical components. More production loss due to failure.	Suitable condition monitoring or inspection technique is required.	Unnecessary replacement is avoided. Full use of asset life.
Reliability-based preventive maintenance	Suitable where failure may result in hazardous and harmful. Safety is prior.	Identify the critical components which require preventive maintenance.	Provide safety to machine and workers.
Predictive Maintenance	Apply for most critical components. Failure of components	Well suitable online condition monitoring technique is required. More initial investment.	Failure can predicted therefore replacement of components just before its failure

Proactive Maintenance	Suitable for all because this is an approach to involve all for assets care	Employee dedication require Motivations and reward for them Proper training for all	Machine availability, operability and reliability can be improved.
Reliability Centred Maintenance	Where safety and reliability of asset is concern. Where machine failure have very hazardous and harmful effects.	Proper and useful failure data are necessary. Identify the most critical component(s).	Avoid hazardous and harmful situations. Assure reliability of assets.
Total Productive Maintenance	Applicable for all This is an approach to involve everyone from top management to shop floor worker for the maintenance of assets	Difficult to train or involve everyone for maintenance activities. Sometimes production workers resist doing maintenance.	Better care of machines can be done.
Computer Maintenance Management System	Best suitable for automated firms.	All data related to failure, spare parts, maintenance resource requirement, execution of problems, human resource skills and their scheduling. More investment.	Easy data available. Alarm maintenance activities. Better care of assets.

Table- 1.Maintenance Strategy Adoption Chart

IV. CONCLUSION

The adoption of maintenance strategy for any plant asset is very difficult decision. The decision must be result that the machine run at its specified level and cost of maintenance is also optimal. The decision to select proper maintenance strategy for caring of plant assets is very important. There are a lot of maintenance strategies for the plant maintenance; to select proper maintenance strategy; we must know about it suitability, limitations and benefits. This paper directs us to select proper maintenance strategies by short and concise way through 'maintenance strategy adoption chart (Table-I)'. The proper adoption of maintenance strategy have lot of benefits like; run the machines at its specified performance level, increase the availability, reliability, prolong life-span etc.

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