Replacement Practice for Components, Essential Tools for Equipment and Machines Effectiveness in Industrial Production

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Abstract- Equipment Replacement is a part of maintenance given to a system to run effectively and efficiently. A lot of researchers have carryout much research work to determining the specific time of replacement through various models. Theory of replacement is normally concern with the problem of replacement of machines, man and decreased efficiency, equipments due to deterioration , break down or failure. Base on several research or studied by researchers on Replacement problem which is an essential theme in management science and operation research .Many writers have assumed that the framework in the working situation where degradation or wear of a unit can be measured and have formulate various models for replacement .

This paper work focus on Replacement Practice for Components, Essential Tools for Equipment and Machines Effectiveness in Industrial Production. the importance of replacement and defines the necessity of the replacement and highlights various reasons for replacement.

Index Terms- Replacement Reasons, Maintenance, Constant Usage, Qualitative Assessment.

I. Introduction

In industrial sectors, the high rate of breakdown of production machine is one of the disturbances on the production flow lines or floor and this problem is affecting the profitability of the industry and the profit cannot be maximised due to maintenance cost and increasing production loss. Many time, this breakdown of machine is contributed by either single component failure or failures between components (Li and Thompson, 2005)

The major conflict lies in deciding that "Should we replace an asset that we own now or later". This paper analyzing essential things that the manufacturers and owners needs to considered and supports them in taking their decision on the area of equipment and machine replacement by exploding the numerous possibilities of taking replacement decision Bharti Sahu (2013).

The purpose of replacement is to ensure efficiency, effectiveness, availability, reliability, maintainability, capability for the Economic life of the equipment and machine i.e. the period of time in terms of years that yields the minimum equivalent uniform annual cost (EUAC) of owning and operating an asset or equipment Nitin Kumar Sahu (2013).

Effectiveness is defined by an equation as a figure-of-merit judging the opportunity for producing the intended results. The effectiveness equation is described in different formats (Blanchard 1995, Kececioglu 1995, Landers 1996, Pecht 1995, Raheja 1991).Each effectiveness element varies as a probability. Since components of the effectiveness equation have different forms, Definitions of the effectiveness equation, and it's components, generate many technical arguments. The major (and unarguable economic issue) is finding a system effectiveness value which gives lowest long term cost of ownership using life cycle costs, (LCC) (Barringer 1996a and 1997) for the value received: System effectiveness = Effectiveness/LCC

Cost is a measure of resource usage. Lower cost is generally better than higher costs.Cost estimates never include all possible elements but hopefully includes the most important elements. Effectiveness is a measure of value received. Clements (1991) describes effectiveness as telling how well the product/process satisfies end user demands. Higher effectiveness is generally better than lower effectiveness. Effectiveness varies from 0 to 1 and rarely includes all value elements as many are too difficult to quantify. One form is described by Berger (1993): Effectiveness=availability*reliability*maintainability*capability. Reliability is defined as the probability that a device will perform its required function under stated conditions for a specific period of time. Predicting The Replacement theory is a decision making process of replacing a used equipment with a alternate substitute; mostly by a new equipment of superior practice. The replacement might be necessary due to the deteriorating property or malfunction or breakdown of particular equipment. Replacement Theory is used in many cases such as accessible items have outlived, or it may not be economical any longer to continue with them, or the items might have been ruined their life or destroyed either by accident or else, Anoop Kumar Sahu (2013). The life of any operating asset generally follow failure pattern and is represented by bath tub curve.

The bath-tub curve is a representation of the reliability performance of components or non-repaired items. It observes the reliability performance of a large sample of homogenous items entering the field at some start time (usually zero). If we observe the items over their lifetime without replacement then we can observe three distinct shapes or periods. Figure 1, shows the bath-tub curve and these 3 periods. The infant mortality or early failures portion shows that the population will initially experience a high hazard function that starts to decrease. This period of time represents the burn-in or debugging period where weak items are weeded out.

After the initial phase when the weak components have been weeded out and mistakes corrected, the remaining population reaches a relatively constant hazard function period, known as the useful life period. From figure 1, the hazard function is constant, this shape can be modelled by the exponential distribution, when failure are occurring randomly through time. The final portion of the bath-tub curve is called the wear-out phase, this is when the hazard function increases with time. When the failure rate (number of failures per unit time) is plotted against a continuous time scale then the resulting curve is known as bath tub curve which exhibits three zones as shown in Fig (1) below:

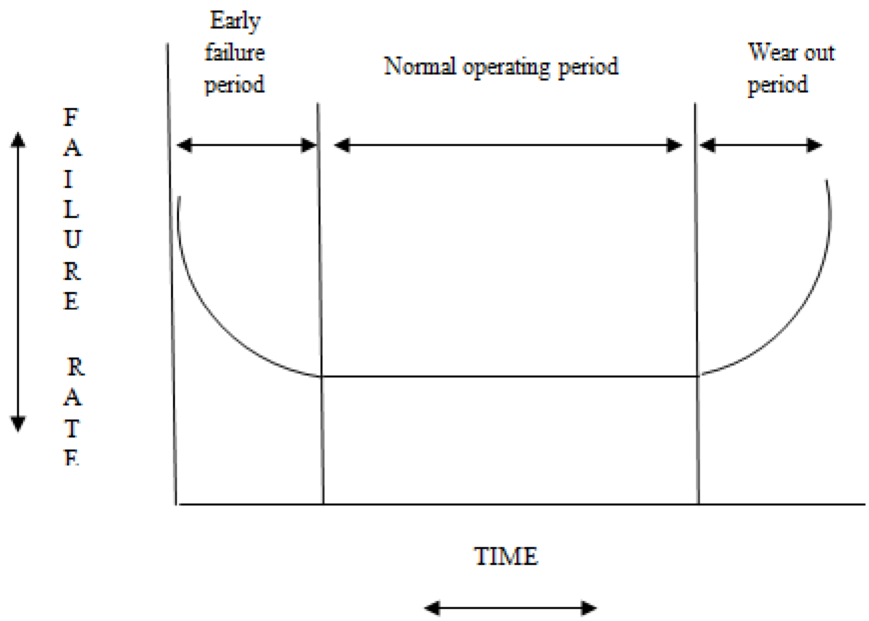

Figure: 1 Bath tub curve

In the third stage the curve represents high maintenance due to abrasion, creep, fatigue, corrosion, vibration etc. after the end of that phase the machinery generally replaces by the owner or manufacturer as it becomes useless as the metal becomes embrittled and the insulation dries out, Atul Kumar Sahu (2013).
The work outline here shown that irrespective of the third phase of bath curve there can be the various different possibilities and the unlikely cases which demands the requirement of replacement .the work presented would like to draw the attention of the owner in the field of replacement. The **Fig (2)** presented depicts the differential requirement of the maintenance action between the new and old equipment with respect to time.

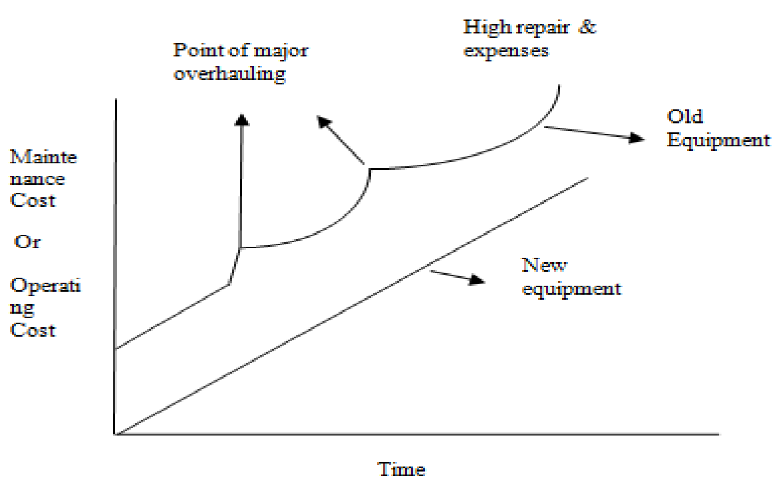

Figure 2: Differential requirement of the maintenance action between the new and old equipment with respect to time.

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Life of the Asset

The estimated life of an asset has a major influence on life cycle cost analysis. Ferry *et al* (1991) has defined the following five possible determinants of an asset's life expectancy:

Functional life - the period over which the need for the asset is anticipated.

Physical life – the period over which the asset may be expected to last physically, to when replacement or major rehabilitation is physically required.

Technological life – the period until technical obsolescence dictates replacement due to the development of a technologically superior alternative.

Economic life – the period until economic obsolescence dictates replacement with a lower cost alternative.

Social and legal life – the period until human desire or legal requirement dictates replacement.

The cost of ownership approach identifies all future costs and reduces them to their present value by use of the discounting techniques through which the economic worth of a product or product options can be assessed(Woorward, 1997).

Life Cycle Cost

The life cycle cost of the equipment/machines is generally composed of original cost, salvage value, operating costs, maintenance costs, renewal costs, decommissioning costs and is represented by the following function :

F(x) = P-Q+R+S+T+U

Where

F(x) = Life Cycle Cost
P = Original Cost
Q = Salvage Value
R = Operating Costs
S = Maintenance Costs
T =Renewal Costs
U =Decommissioning Costs

When the average life cycle cost of the equipment is minimum, then after the end of that time span the replacement is usually preferable, the life cycle cost of the equipment generally deals with the quantitative assessment and deals with cost optimization. The work presented here shows the requirement of replacement based on qualitative assessment rather than quantitative.

Figure 3: Reason for Replacement of Assets

Opportunity of handling extra additional operations by innovative machines	Reduction in consumption of power or fuel by the innovative machine	Percentage increase in maintenance costs, decline in product quality	Reduction in down time by new machine due to breakdown or repairs
Deduction in scrap or spoiled work by new machines	**Reasons for Replacement of Assets**		Reduction in rate of output, increment in labor costs.
Fall in Profit and to stay rival in the market due to changed machinery			Smoky, noisy, hazardous working conditions and pollution by old machines leading to accidents and causing workers un-safety.
Development of lesser space requirement & new reliable machines	Depreciation due to wear and tear	Spare parts unavailability	Obsolescence as a result of technological expansion

Large number of factors is responsible to replace the equipments before its estimated useful life .The various possible reasons which necessitate the replacement of equipment and machines are :

☐ Depreciation of the equipments due to wear and tear
☐ Increment in maintenance costs, reduction in product quality.
☐ Decrement in rate of output, increase in labor costs etc
☐ Unavailability of spare parts
☐ Possibility of performing additional operations by new machines

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☐ Obsolescence caused due to technological development
☐ Profit reduction and competitive strength of the firm to remain rival in the market due to changed machinery
Change in product design or automation
☐ Reduction in scrap or spoiled work by new machines.
☐ Reduced safety as compared to new machines available and developed
☐ Replacing old machines which creates unpleasant i.e. smoky ,noisy ,pollution and hazardous working conditions causing workers un-safety and leading to accidents
☐ More reliable machines developed
☐ Saving resulting from consumption of less power or fuel by the new machine
☐ High maintenance and repair cost of existing equipments and machines
☐ Improvement in quality and productivity by the use of new machine
☐ To reduce down time of existing equipments due to breakdown, repairs
☐ Reduction in the cost of jigs, fixtures, special tools etc by the use of new machines.
☐ Salvage value of new equipment and its useful life
☐ Lesser space requirement by the new machine

Flow Chart of Proposed Approach to Replacement

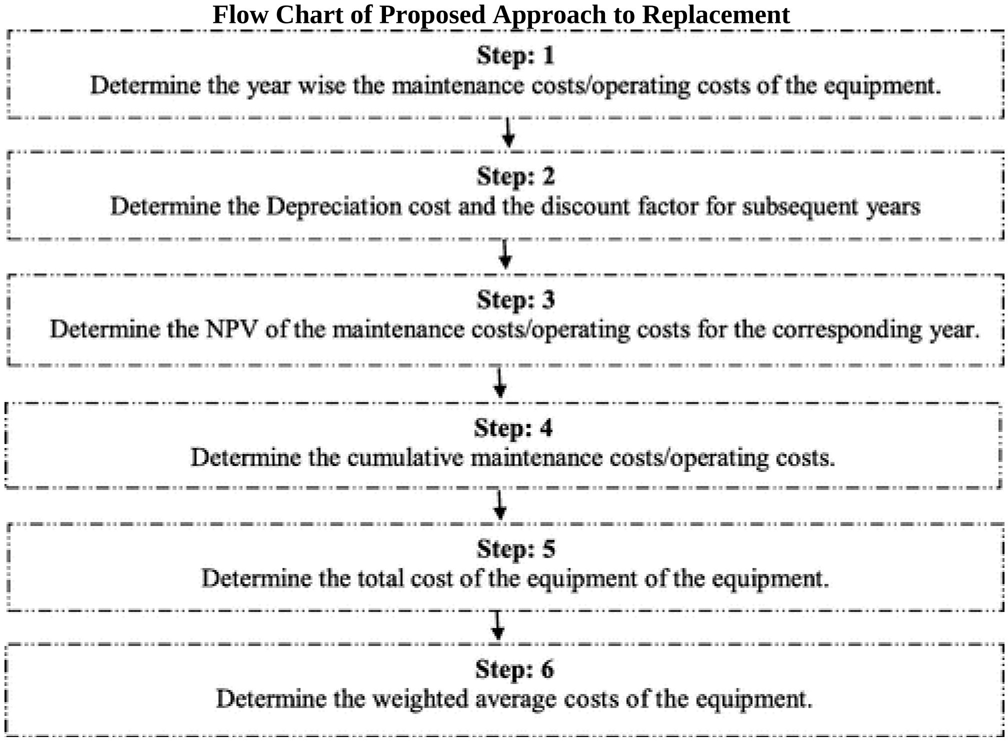

Figure 4. Flow chart of proposed approach to replacement

Factor Affecting Maintenance Costs

Maintenance cost could be affected by the following factors:

1. Supply responsiveness or the probability of having a spare part available when needed, supply lead times for given items, levels of inventory, and so on.
2. Test and support equipment effectiveness, which is the reliability and availability of test equipment, test equipment utilisation, system test thoroughness, and so on.
3. Maintenance facility availability and utilisation.
4. Transportation times between maintenance facilities.
5. Maintenance organisational effectiveness and personnel efficiency.
6. Durability and reliability of items in the system
7. Life expectancy of system
8. Expected number of maintenance tasks
9. Duration of maintenance and support task
10. Maintenance task resources

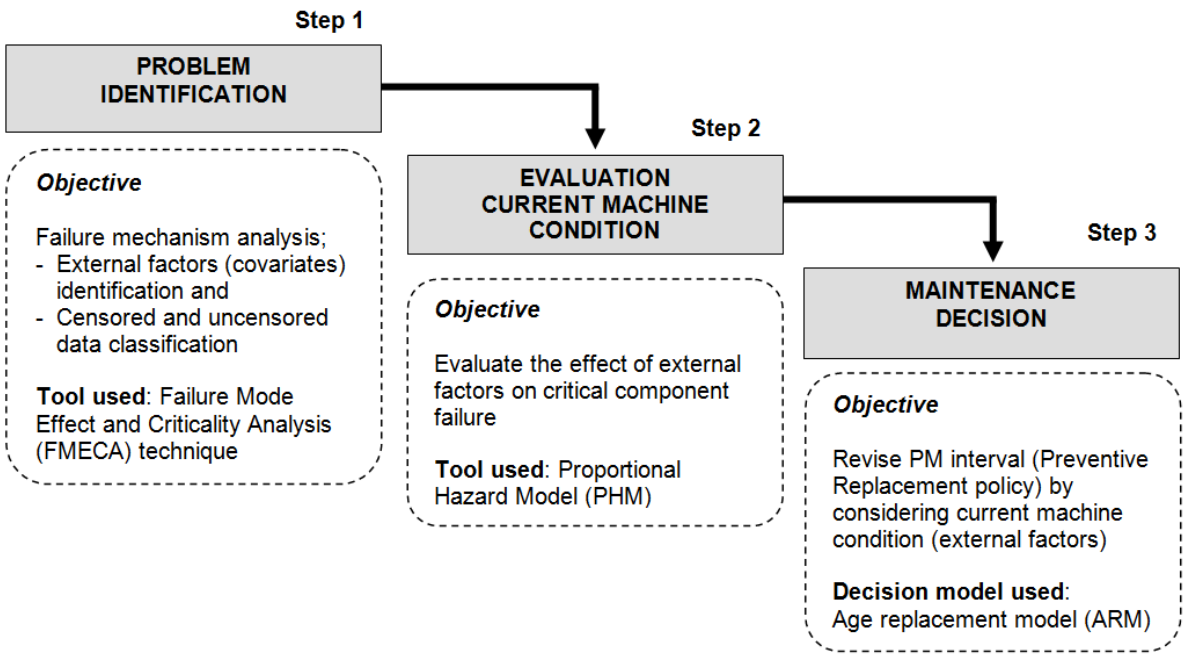

Figure 5: The general structure of the maintenance management decision model.

Failure Forecasts and Predictions

When failures occur in service, a prediction of the number of failures that will occur in the fleet in the next period of time is desirable, (say six months, a year, or two years). To accomplish this, a risk analysis procedure for forecasting future failures are developed. A typical failure forecast is shown in Figure 6, Cumulative future failures are plotted against future months. This process provides information on whether the failure mode applies to the entire population or fleet, or to only one portion of the fleet, called a batch. After alternative plans for corrective action are developed, the failure forecasts are repeated. The decision-maker will require these failure forecasts to select the best course of action, the plan with the minimum failure forecast or the minimum cost. If failed parts are replaced as they fail; the failure forecast is higher than without replacement.

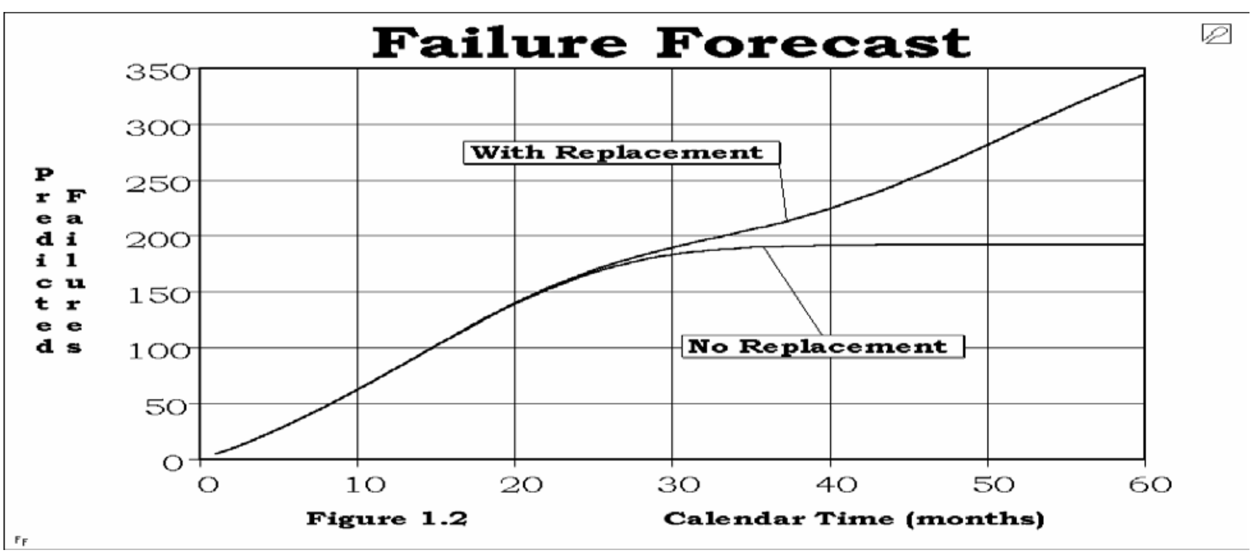

Figure 6 . Failure Forecast

II. Conclusion

Many researchers studied the machine replacement problem which is a significant area in operations research, industrial engineering and management science. Items which are under regular and constant usage experience replacement at an appropriate time due to competence and efficiency of the working system. In the work we highlighted that many people feel that equipment should not be replaced until it is bodily and physically worn out. But, it is not right, operational equipment must be regularly ,persistently and constantly rehabilitated and modernized and updated to remain competitive and to retain efficiency otherwise it will be in the menace of malfunction or it may become obsolete and out dated.

The paper discusses the value and importance of replacement in production atmosphere. The objective of the proposed work focuses on Replacement Practice for Components, Essential Tools For Equipment And Machines Effectiveness In Industrial Production and striking a balance between the cost and the competitive environment. The possibilities of equipment replacement are discussed to ensure delivering the normal performance of the equipment. This script also discusses the life cycle and the life cycle cost of the assets. These work discussed with respect to the parameters like maintenance cost, time and obsolescence.

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