Replacement Analysis

Reasons for replacement are

1) Deterioration: Wear & tear of assets increases maintenance cost
2) Obsolescence: Advancement in technology causes value loss of machinery
3) Inadequacy: Present equipments or machinery may be insufficient to meet desired demand/level of production
4. Working Conditions: Present machinery may be hazardous leading to accidents, making environment noisy and smoky.
5. Economy: The existing machinery has outlived its effective life and not economical for further use.

Replacement reduces maintenance cost. It is a misconception that equipments should not be replaced untill these are worn out completely on the contrary, these must be continuously reviewed.

1) Replacement of items that deteriorate with time
   a) without considering time value of money
   b) considering time value of money.
2) Replacement of items that fail suddenly and completely

1) a Replacement of items that deteriorate with time without considering time value of money.

Maintenance cost $g(t)$ can be either discrete or continuous

Cummulative Maintenance cost after n no. of years

$$M(n) = \sum_{t=0}^{n} g(t) \quad \text{when } t \text{ is discrete}$$

$$M(n) = \int_{0}^{n} g(t)\,dt, \quad \text{when } t \text{ is continuous.}$$

Total Cost $= C + M(n) - S(n)$ | Average cost: $\frac{C + M(n) - S(n)}{n}$ (2)

C = Cost of item

M(n) – Total maintenance cost in period n

S(n) = Scrap value in period n

Prob A manufacturer from the past records finds the costs associated with machine having buying cost of Rs 5000 are as follows:

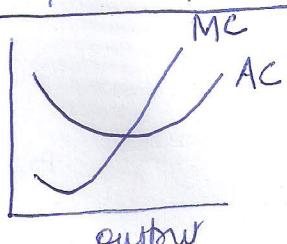
Year (t)	1	2	3	4	5	6	7	8
Running / Maintenance cost g(t)	1500	1600	1800	2100	2500	2900	3400	4000
Scrap S(t)	3500	2500	1700	1200	1000	500	500	500

Year (1)	S(t) (2)	C – S(n) (3)	g(t) (4)	M(n) (5)	C + M(n) – S(n) (6 = 3 + 5)	G(n) = C + M(n) – S(n) / n (7 = 6 ÷ 1)
1	3500	1500	1500	1500	3000	3000
2	2500	2500	1600	3100	5600	2800
3	1700	3300	1800	4900	8200	2733.33
4	1200	3800	2100	7000	10800	2700
5	1000	4000	2500	9500	13500	2700
6	500	4500	2900	12400	16900	2816.67
7	500	4500	3400	15800	20300	2900
8	500	4500	4000	19800	24300	3037.5

Decision Rule $G(n) < g(n+1)$ and $g(n) < G(n-1)$

Replace the item, when next years maintenance cost is more than select year's Average cost and select year's maintenance cost is less than previous year's Average cost. Or in other words, when Average cost is at its minimum. In the present example, Replacement period is 5 years

At this point, the maintenance cost of 5th year (2500) is less than previous year's (4th yr) Average cost (2700) and next year's maintenance cost (2900 of 6th yr) is less than Average cost (2700) of select year (5th year).



Marginal cost (MC) $= \frac{\Delta TC}{\Delta Q}$ or $\frac{\Delta TC}{\Delta t}$ is change in total cost either with output or time. In this case, maintenance / running cost is marginal cost, ignoring scrap value. When MC < AC, it Pulls AC downwards, when MC > AC, it Pulls AC upwards. MC cuts AC at its minimum point

$AC = \frac{C}{x}$ | $C = TC$

$MC = \frac{d(C)}{dx}$

$\frac{\partial (C/x)}{\partial x} = \frac{x \cdot \frac{\partial C}{\partial x} - C}{x^2} = 0$

$= \frac{1}{x}\left(\frac{\partial C}{\partial x} - \frac{C}{x}\right) = 0$

$= \frac{1}{x}(MC - AC) = 0$

It will be minimum when MC = AC.