Replacement Theory
in
Operations Research

The Theory

- The Replacement Theory in Operations Research is used in the decision making process of replacing a used equipment with a substitute; mostly a new equipment of better usage. The replacement might be necessary due to the deteriorating property or failure or breakdown of particular equipment.

Replacement Models

- The 'Replacement Theory' is used in the cases like; existing items have out-lived, or it may not be economical anymore to continue with them, or the items might have been destroyed either by accident or otherwise. The above discussed situations can be solved mathematically and categorised on some basis which may be called as Replacement Models.

Model-I: Aging of Machines

- Items that deteriorate with time e.g. machine tools, vehicles, equipment buildings …

Illustration: A truck-owner finds out maintenance cost for Truck-X to be Rs 200 for the first year & increasing by Rs 2000 every year hence; capital cost of which is Rs 10000. Determine the replacement age.

Model-II: Availability of Similar New Machines with Better Usages

- Items becoming out-of-date due to new developments like ordinary weaving looms by automatic, manual accounting by tally, computers, cars …

Illustration: A truck-owner finds out maintenance cost for Truck-X to be Rs 200 for the first year & increasing by Rs 2000 every year hence; capital cost of which is Rs 9 000. Truck-Y costs Rs 20 000 whose annual maintenance cost is Rs 400 for first year & then increases by Rs 800 every year. The Truck owner has now Truck-X of 1 year age, should he replace it by Truck-Y, and if so, when?

Model-III: Time Value of Machines Considered
–Depreciation of Money or Present Worth Factor

- Items which deteriorate with time
- The depreciation of money is considered in calculations

Illustration: A Lathe Machine costs Rs 5000 whose maintenance cost is Rs 1000 in each of the first 4 years & then increases by Rs 200/- every year. Assuming that machine has no salvage value & the maintenance cost is incurred in the beginning of each year, determine the optimal replacement time for the lathe assuming that time value of money is 10 % p. a.

Model-IV: Group Replacements

- Items which do not deteriorate but fail completely after certain amount of use like electronic parts, street lights...

- **Illustration:** An office has 1000 bulbs installed of which 20% bulbs keeps on failing each week. Individual Bulb replacement costs Rs 3; while Group Replacement costs Re 1 per bulb. It is decided to replace all the bulbs simultaneously at fixed interval & also to replace the individual bulbs that fail in between. Decide a suitable replacement policy.