# SOS POLITICAL SCIENCE AND PUBLIC ADMINISTRATION
# MBA FA 204
# SUBJECT NAME: OPERATION RESEARCH

**TOPIC NAME:**

**Replacement 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 orbreakdown of particular equipment. 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 categorizedon some basis like: Items that deteriorate with time e.g. machine tools, vehicles,equipmentbuildings etc. Items becoming out-of-date due to new developments like ordinary weaving looms by automatic, manual accounting by tally etc. Items which do not deteriorate but fail completely after certain amount of use like electronic parts, street lights etc(GroupReplacement)and The existing working staff in an organization gradually diminishing due to death, retirement, retrenchment & otherwise(StaffReplacement).ReplacementPolicyforEquipmen twhichDeteriorateGraduallyLet us see the fiUSDtcase of gradual failure of items with time. Consider the example of a Motor Vehicle; the pattern of failure here is progressive in nature i.e. as the life of vehicle increases; its efficiency decreases. This results in additional expenditure in running ormaintaining this vehicle and at the same time its resale value (also called as scrap value) also keeps on decreasing.

The above case makes this situation a typical case for applying „Replacement Theory".

2Example:A transport company purchased a motor vehicle for rupees 80000/-. The resale value of the vehicle keeps on decreasing from USD70000/-in the fiUSDt year to USD5000/- in the eighth year while, the running cost in maintaining the vehicle keeps on increasing with USD. 3000/-in the fiUSDt year till it goes to USD. 20000/-in the eighth year as shown in the below table. Determine the optimum replacement policy?The MS-Excel Files of this Algorithm can be downloaded from the links provided further in this post. The cost of the equipment is to be entered in the cell B1 (as shown by the green cell with 80000). Now, enter the scrap values and the running costs as entered in the green columns C5 to C12 and D5 to D12.The algorithm will now automatically calculate the solution which is as shown in thebelow figure.The answer can be fetched from the last column. See the pattern; the average total cost (ATC) at first starts dipping from USD. 13000/-till it reaches USD. 11850/-in the cell H8.

From H9 it again starts increasing. This cost at which theATC is lowest in a particular year (after which it starts increasing again) gives the optimum

replacement period and cost of the vehicle.Solution:The vehicle needs to be replacedafterfouryearsof its purchase wherein the cost of maintaining that vehicle would be lowest at an average ofUSD11850/-per year.
3ClarificationontheMethodologyThere are two considerations here. First, the running cost (Rn) is increasing every year at the same time the vehicle is depreciating in its value. This depreciation is„(C-S)" i.e. in the firstyear the scrap value of the vehicle is USD. 70000/-which was purchased for USD.

80000/-. So, the vehicle is depreciated by USD. 10000/-in year one and so on (see column F).Thus the total cost in keeping this vehicle is this depreciation and its maintenance. The maintenance is made cumulative by adding previous yearsrunning cost to it every successive year. Let"s make this simple!The depreciation is USD. 10000/-in the first, 19000/-in the second, 25000/-in the third and so on. See here, the vehicle is depreciated byUSD.25000/-"by" the third year and not "in" the third year. Note that the non-cumulative cost of depreciation "in" the third year would be USD. 6000/-[USD.
25000/ minus USD. 19000/, see the cells F6 and F7]As, the depreciation in itself is a cumulative function here, we make the running cost cumulative also. That means the cost of maintaining the vehicle "by" the particular years. So, the cost of maintaining the vehicle "by" the third year isUSD.11400/- (D5+D6+ D7 or 3000+3600+4800).Hence the total cost incurred by the third year would be USD. 25000 + USD.
11400 = USD. 36400 (see cell G7). Finally, the "average cost" of keeping this vehicle for three yearswould be 36400 divided by 3 yearsi.e. USD. 12133.33 as can be seen from cell H7 and so on.

NotationsUsed:

- C–(Capital) Cost of Equipment
- S–Scrap (or Resale) Value
- Rn–Running (or Maintenance) Cost
- ERn–Cumulative Running Cost
- (C-S)–Depreciation
- TC–Total Cost
- ATC–Average Total Cost