Replacement of items/Assets that fail Completely and Suddenly

There are some items that fail suddenly and completely. As a result, the entire system or production process comes to halt suddenly. Due to breakdown, the other units of production, labour etc become idle. It amounts to losses. The replacement policy under such a situation is of two types

a) Individual replacement policy : When an item fails, it should be replaced immediately.

b) Group replacement policy : All items to be replaced after a certain period of time despite the fact these are working and with a provision of replacing an individual item when it fails. Due to group replacement, probability of breakdown decreases.

Prob. A Computer has 10,000 resistors. When any resistor fails, it is replaced. The cost replacing a resistor individually is $1. If all resistors are replaced at the same time, the cost per resistor will be $0.35. The percent Surviving rate S(t) at the end of month and probability of failure p(t) during the month are as follows:

t	0	1	2	3	4	5	6
S(t)	100	97	90	70	30	15	0
P(t)		0.03	0.07	0.20	0.40	0.15	0.15

What is optimum replacement plan?

The whole problem will be divided into two categories

(i) Individual replacement

(ii) Group replacement.

Replacements during each month

N_0 = No. of resistors in the beginning = 10,000

$N_1 = N_0 P_1 = 10,000 \times 0.03 = 300$

$N_2 = N_0 P_2 + N_1 P_1 = (10,000 \times 0.07) + (0.03 \times 300) = 709$

$N_3 = N_0 P_3 + N_1 P_2 + N_2 P_1 = (10,000 \times 0.20) + (300 \times 0.07) + (709 \times 0.03) = 2042$

$N_4 = N_0 P_4 + N_1 P_3 + N_2 P_2 + N_3 P_1 (10,000 \times 0.40) + (300 \times 0.20) + (709 \times 0.07) + (2042 \times 0.03) = 4171$

$N_5 = N_0 P_5 + N_1 P_4 + N_2 P_3 + N_3 P_2 + N_4 P_1$

$= (10,000 \times 0.15) + (300 \times 0.40) + (709 \times 0.20) + (2042 \times 0.07) + (4171 \times 0.03) = 2030$

$N_6 = N_0 P_6 + N_1 P_5 + N_2 P_4 + N_3 P_3 + N_4 P_2 + N_5 P_1$

$= (10,000 \times 0.15) + (300 \times 0.15) + (709 \times 0.40) + (2042 \times 0.20) + (4171 \times 0.07) + (2030 \times 0.03)$

$= 2590$

Expected Life of Resistor $= \Sigma X_i P_i$ (X_i life in months i, P_i - its probability)

$= (1 \times 0.03) + (2 \times 0.07) + (3 \times 0.20) + (4 \times 0.40) + (5 \times 0.15) + (6 \times 0.15)$

$= 4.02$ months.

Average number of replacements per month $= \frac{\text{total items}}{\text{Expected life of item}} = \frac{10,000}{4.02} = 2488$

Average cost per month of individual replacement (@ $1 per item) $= 2488 \times 1 = \$2488$

Gomp Replacement Policy.

At the end of month	Total cost of gomp replacement	Average cost/month
1	$(300 \times 1) + (10,000 \times 0.35) = 3800$	3800
2	$[(300 + 709) \times 1] + (10,000 \times 0.35) = 4509$	2254.50
3	$[(300 + 709 + 2042) \times 1] + (10,000 \times 0.35) = 6551$	2183.66
4	$[(300 + 709 + 2042 + 4171) \times 1] + (10,000 \times 0.35) = 10722$	2680.50
5	$[(300 + 709 + 2042 + 4171 + 2030) \times 1] + (10,000 \times 0.35) = 12752$	2550.40
6	$[(300 + 709 + 2042 + 4171 + 2030 + 2590) \times 1] + (10,000 \times 0.35) = 15442$	2557.00.

Average cost is least at the end of period (month) 3 in case of gomp replacement. It will be compared with Average cost of individual replacement. If least average cost of gomp replacement is less than average cost of individual replacement the firm should go for gomp replacement at the end of that period. Otherwise, if least average cost of gomp replacement is more than average cost of individual replacement, then it should follow only individual replacement policy.

Prob

A factory has 1000 bulbs installed. Cost of individual replacement is Rs 3/- while that of group replacement is Re 1/- per bulbs. Failure probabilities are as follows.

Week	1	2	3	4	5
Failure probability (P)	0.10	0.25	0.50	0.70	1.00

Failure probability is cummulative. Failure probability needs to be split into failure probabilities of respective weeks, which are as follows

Week	1	2	3	4	5
Failure Probability P(t)	0.10	0.15	0.25	0.20	0.30
