End of Year (1)	Annual O&M Cost ₹ (2)	Book Value $BV_x = BV_{n-1} - D_x$	Annual Depreciation Expense ₹ (3) 40% of BV_{n-1}	Annual Cost ₹ (4)=(2)+(3)	Cumulative Cost ₹ (5)	Average Annual Cumulative Cost ₹ (6)=(5)/(1)
Proposed loaders (Challenger) Annual O&M cost is ₹12,00,000 and increase by ₹60,000 per year				Cost of loader = ₹28,00,000		
1	12,00,000.00	16,80,000.00	11,20,000.00	23,20,000.00	23,20,000.00	23,20,000.00
2	12,60,000.00	10,08,000.00	6,72,000.00	19,32,000.00	42,52,000.00	21,26,000.00
3	13,20,000.00	6,04,800.00	4,03,200.00	17,23,200.00	59,75,200.00	19,91,733.33
4	13,80,000.00	3,62,880.00	2,41,920.00	16,21,920.00	75,97,120.00	18,99,280.00
5	14,40,000.00	2,17,728.00	1,45,152.00	15,85,152.00	91,82,272.00	18,36,454.40
6	15,00,000.00	1,30,636.80	87,091.20	15,87,091.20	107,69,363.20	17,94,893.87
7	15,60,000.00	78,382.08	52,254.72	16,12,254.72	123,81,617.92	17,68,802.56
8	16,20,000.00	47,029.25	31,352.83	16,51,352.83	140,32,970.75	17,54,121.34
9	16,80,000.00	28,217.55	18,811.70	16,98,811.70	157,31,782.45	17,47,975.83
10	17,40,000.00	16,930.53	11,287.02	17,51,287.02	174,83,069.47	17,48,306.95
11	18,00,000.00	10,158.32	6,772.21	18,06,772.21	192,89,841.68	17,53,621.97
12	18,60,000.00	6,094.99	4,063.33	18,64,063.33	211,53,905.01	17,62,825.42

So, depreciation for the first year is nothing but 0.4 into book value.

$$D_1 = 0.4 \times 28{,}00{,}000 = 11{,}20{,}000 \text{ rupees}$$

So, now you calculate the book value at the end of first year, so what is the book value at the beginning of year that is nothing but your purchase price of the machine 28 lakh minus the depreciation for the first year. That is nothing but 11,20,000, that gives you the book value at the end of the first year as 16,80,000 so hope you can understand. So, let us work it for the second year.

(Refer Slide Time: 21:08)

End of Year (1)	Annual O&M Cost ₹ (2)	Book Value $BV_x = BV_{n-1}$ D_x	Annual Depreciation Expense ₹ (3) 40% of BV_{n-1}	Annual Cost ₹ (4)=(2)+(3)	Cumulative Cost ₹ (5)	Average Annual Cumulative Cost ₹ (6)=(5)/(1)
Proposed loaders (Challenger) Annual O&M cost is ₹12,00,000 and increase by ₹60,000 per year				Cost of loader = ₹28,00,000		
1	12,00,000.00	16,80,000.00	11,20,000.00	23,20,000.00	23,20,000.00	23,20,000.00
2	12,60,000.00	10,08,000.00	6,72,000.00	19,32,000.00	42,52,000.00	21,26,000.00
3	13,20,000.00	6,04,800.00	4,03,200.00	17,23,200.00	59,75,200.00	19,91,733.33
4	13,80,000.00	3,62,880.00	2,41,920.00	16,21,920.00	75,97,120.00	18,99,280.00
5	14,40,000.00	2,17,728.00	1,45,152.00	15,85,152.00	91,82,272.00	18,36,454.40
6	15,00,000.00	1,30,636.80	87,091.20	15,87,091.20	107,69,363.20	17,94,893.87
7	15,60,000.00	78,382.08	52,254.72	16,12,254.72	123,81,617.92	17,68,802.56
8	16,20,000.00	47,029.25	31,352.83	16,51,352.83	140,32,970.75	17,54,121.34
9	16,80,000.00	28,217.55	18,811.70	16,98,811.70	157,31,782.45	17,47,975.83
10	17,40,000.00	16,930.53	11,287.02	17,51,287.02	174,83,069.47	17,48,306.95
11	18,00,000.00	10,158.32	6,772.21	18,06,772.21	192,89,841.68	17,53,621.97
12	18,60,000.00	6,094.99	4,063.33	18,64,063.33	211,53,905.01	17,62,825.42

So, for the second year the depreciation is nothing but D2 is 0.4 into book value the end of first year,

$$\mathbf{D_2 = 0.4 \times 16,80,000 = 6,72,000 \text{ rupees}}$$

Now calculate the book value at the end of second year, it is nothing but book value at the end of the first year minus the depreciation for the second year.

So, what is the book value at the end of first year? It is nothing but 16,80,000 minus your depreciation for the second year is 6,72,000 that gives me the book value at the end of second year as 10,8000. So, like this you calculate the depreciation for all the years and the corresponding book values also you have to estimate. Now you can estimate the annual cost by adding the operating and the maintenance cost as the depreciation. When you add column 2 and the column 3 you will get the annual costs for every year. So, what is the annual cost for the first year?

(Refer Slide Time: 22:27)

End of Year (1)	Annual O&M Cost ₹ (2)	Book Value $BV_n = BV_{n-1} - D_n$	Annual Depreciation Expense ₹ (3)	Annual Cost ₹ (4)=(2)+(3)	Cumulative Cost ₹ (5)	Average Annual Cumulative Cost ₹ (6)=(5)/(1)
Proposed loaders (Challenger) Annual O & M cost is ₹12,00,000 and increase by ₹60,000 per year			40% of BV_{n-1}		Cost of loader = ₹ 28,00,000	
1	12,00,000.00	16,80,000.00	11,20,000.00	23,20,000.00	23,20,000.00	23,20,000.00
2	12,60,000.00	10,08,000.00	6,72,000.00	19,32,000.00	42,52,000.00	21,26,000.00
3	13,20,000.00	6,04,800.00	4,03,200.00	17,23,200.00	59,75,200.00	19,91,733.33
4	13,80,000.00	3,62,880.00	2,41,920.00	16,21,920.00	75,97,120.00	18,99,280.00
5	14,40,000.00	2,17,728.00	1,45,152.00	15,85,152.00	91,82,272.00	18,36,454.40
6	15,00,000.00	1,30,636.80	87,091.20	15,87,091.20	107,69,363.20	17,94,893.87
7	15,60,000.00	78,382.08	52,254.72	16,12,254.72	123,81,617.92	17,68,802.56
8	16,20,000.00	47,029.25	31,352.83	16,51,352.83	140,32,970.75	17,54,121.34
9	16,80,000.00	28,217.55	18,811.70	16,98,811.70	157,31,782.45	17,47,975.83
10	17,40,000.00	16,930.53	11,287.02	17,51,287.02	174,83,069.47	17,48,306.95
11	18,00,000.00	10,158.32	6,772.21	18,06,772.21	192,89,841.68	17,53,621.97
12	18,60,000.00	6,094.99	4,063.33	18,64,063.33	211,53,905.01	17,62,825.42

Your operating in the maintenance cost for the first year is 12 lakh and your depreciation for the first year is 11,20,000, so your annual cost will be

Annual cost of first year = 11,20,000+12,00,000 = 23,20,000 rupees

Annual cost of second year = 6,72,000+12,60,000 = 19,32,000 rupees

So, like this you keep calculating for all the years with every year you can calculate the annual cost.

Then you can calculate the cumulative cost, then find the average annual cumulative cost. So, like we did for the earlier old loader or the current loader or the defender. So, now, how will you calculate the average annual cumulative cost?

End of Year (1)	Annual O&M Cost ₹ (2)	Book Value $BV_x = BV_{x-1} - D_x$	Annual Depreciation Expense ₹ (3)	Annual Cost ₹ (4)=(2)+(3)	Cumulative Cost ₹ (5)	Average Annual Cumulative Cost ₹ (6)=[5]/(1)
Proposed loaders (Challenger)			40% of BV_{x-1}			
Annual O&M cost is ₹12,00,000 and increase by ₹60,000 per year				Cost of loader = ₹28,00,000		
1	12,00,000.00	16,80,000.00	11,20,000.00	23,20,000.00	23,20,000.00	23,20,000.00
2	12,60,000.00	10,08,000.00	6,72,000.00	19,32,000.00	42,52,000.00	21,26,000.00
3	13,20,000.00	6,04,800.00	4,03,200.00	17,23,200.00	59,75,200.00	19,91,733.33
4	13,80,000.00	3,62,880.00	2,41,920.00	16,21,920.00	75,97,120.00	18,99,280.00
5	14,40,000.00	2,17,728.00	1,45,152.00	15,85,152.00	91,82,272.00	18,36,454.40
6	15,00,000.00	1,30,636.80	87,091.20	15,87,091.20	107,69,363.20	17,94,893.87
7	15,60,000.00	78,382.08	52,254.72	16,12,254.72	123,81,617.92	17,68,802.56
8	16,20,000.00	47,029.25	31,352.83	16,51,352.83	140,32,970.75	17,54,121.34
9	16,80,000.00	28,217.55	18,811.70	16,98,811.70	157,31,782.45	17,47,975.83
10	17,40,000.00	16,930.53	11,287.02	17,51,287.02	174,83,069.47	17,48,306.95
11	18,00,000.00	10,158.32	6,772.21	18,06,772.21	192,89,841.68	17,53,621.97
12	18,60,000.00	6,094.99	4,063.33	18,64,063.33	211,53,905.01	17,62,825.42

It is nothing but your the cumulative cost divided by the cumulative usage of the machine. So, for the first year,

$$\text{Average annual cumulative cost, first year} = \frac{23{,}20{,}000}{1} = 23{,}20{,}000 \text{ rupees}$$

$$\text{Average annual cumulative cost, second year} = \frac{42{,}52{,}000}{2} = 21{,}26{,}000 \text{ rupees}$$

So, the same way you can see the trend here, here also the initially the cost is high then it starts reducing, it reaches a minimum point here, after that it starts increasing you can see it is increasing. So, basically here the economic life of the machine is 9th year for the proposed loader, because the cost is minimum 9th year. So, the economic life of the proposed loader is 9th year but for the old loader the economic life is 8th year.

Now you can compare the average annual cumulative cost of the proposed loader and the old loader. You can see the average annual cumulative costs minimum is 17,99,541.

End of Year (1)	Annual O&M Cost ₹ (2)	Book Value $BV_n = BV_{n-1} - D_n$	Annual Depreciation Expense ₹ (3) 40% of BV_{n-1}	Annual Cost ₹ (4)=(2)+(3)	Cumulative Cost ₹ (5)	Average Annual Cumulative Cost ₹ (6)=(5)/(1)
Proposed loaders (Challenger)						
Annual O & M cost is ₹12,00,000 and increase by ₹60,000 per year				Cost of loader = ₹28,00,000		
1	12,00,000.00	16,80,000.00	11,20,000.00	23,20,000.00	23,20,000.00	23,20,000.00
2	12,60,000.00	10,08,000.00	6,72,000.00	19,32,000.00	42,52,000.00	21,26,000.00
3	13,20,000.00	6,04,800.00	4,03,200.00	17,23,200.00	59,75,200.00	19,91,733.33
4	13,80,000.00	3,62,880.00	2,41,920.00	16,21,920.00	75,97,120.00	18,99,280.00
5	14,40,000.00	2,17,728.00	1,45,152.00	15,85,152.00	91,82,272.00	18,36,454.40
6	15,00,000.00	1,30,636.80	87,091.20	15,87,091.20	107,69,363.20	17,94,893.87
7	15,60,000.00	78,382.08	52,254.72	16,12,254.72	123,81,617.92	17,68,802.56
8	16,20,000.00	47,029.25	31,352.83	16,51,352.83	140,32,970.75	17,54,121.34
9	16,80,000.00	28,217.55	18,811.70	16,98,811.70	157,31,782.45	17,47,975.83
10	17,40,000.00	16,930.53	11,287.02	17,51,287.02	174,83,069.47	17,48,306.95
11	18,00,000.00	10,158.32	6,772.21	18,06,772.21	192,89,841.68	17,53,621.97
12	18,60,000.00	6,094.99	4,063.33	18,64,063.33	211,53,905.01	17,62,825.42

So, for here you can see it is 17,47,975, so can you see here? So, you can see, here it is 17,99,000, here it is 17,47,000. So, it justifies the replacement of your proposed loader with the old loader because the minimum average annual cumulative cost for the challenger is lesser when compared to the old loader which is higher. So, this justifies a replacement. Now, let us see when to replace this current loader with the new loader.

(Refer Slide Time: 25:28)

Minimum cost method

Decision to replace equipment is made when estimated annual cost of current machine for next year exceeds minimum average annual cumulative cost of replacement.

So, Dr. James Douglas has given a guideline for this minimum cost approach to decide when to replace the old machine with the new machine. So, the decision to replace the equipment is made when the estimated annual cost of the current machine for the next year exceeds the minimum average annual cumulative cost of the proposed machine. So, you are going to compare the annual

cost of the current machine for the next year with the minimum average annual cumulative cost of the proposed machine. When the annual costs of the current machine is higher, that is the time you have to plan for the replacement.

(Refer Slide Time: 26:10)

Comparison of average annual cumulative costs.

End of Year	Estimated Annual Cost of current loader ₹	Annual Average Cumulative Cost Current loader ₹	Proposed loader ₹
1	23,46,900.00	22,40,000.00	23,20,000.00
2	19,04,000.00	20,72,000.00	21,26,000.00
3	17,31,100.00	19,59,466.67	19,91,733.33
4	16,64,640.00	18,85,760.00	18,99,280.00
5	16,54,784.00	18,39,564.80	18,36,454.40
6	16,80,870.40	18,13,115.73	17,94,893.87
7	17,28,522.24	18,01,030.05	17,68,802.56
8	17,89,113.34	17,99,541.25	17,54,171.94
9	18,57,468.01	18,05,977.55	17,47,975.83
10	19,30,480.80	18,18,427.88	17,48,306.95
11	20,06,288.48	18,35,506.12	17,53,621.97
12	20,83,773.09	18,56,195.03	17,62,825.42

For current loaders estimated annual cost for next year(end of year 2) is ₹ 19,04,000.00 and this exceeds minimum average annual cumulative cost for new loader ₹ 17,47,975.83 Hence decision is to replace current loaders with newer model.

So, now let us compare as per Dr. James Douglas guideline the estimated annual cost of the machine for the next year. So, next year is nothing but because you are the loaders are already 1 year old. The current loader is 1 year old, so we are finding the estimated annual cost for the second year. Second year the value is 19,04,000, you compare it with the minimum average annual cumulative cost of the proposed loader.

For the proposed loader the minimum average annual cumulative costs is 17,47,975, you compare this and this. Since your annual cost the estimated cost for the current loader for the next year is very much higher than the proposed loader. So, it implies that you have to replace immediately. So, you have to replace the current loader with the new loader as per the Dr. Douglas guidelines.

So, and also as I told you when we compare the average annual community cost of the current loader as well as the minimum loader, these 2 minimum values also if you compare, you can see it justifies replacement. Because for the proposed loader value is lesser when compared to the current loader. So, it means that if you are going to hold their proposed loader with you for 9 years, the average annual cumulative cost which you will incur for the 9 yours will be 17,47,975.

Which is lesser than the estimated annual cost for the current loader for the next year that is second year, so that is why we are replacing it immediately. So, for the current loader estimated annual cost for the next year is 19,04000 and this exceeds the minimum average cumulative cost for a new loader that is 17,47,975. Hence the decision is to replace the current loader with the newer model. So, this is the finding or the decision based on the minimum cost method.

(Refer Slide Time: 28:26)
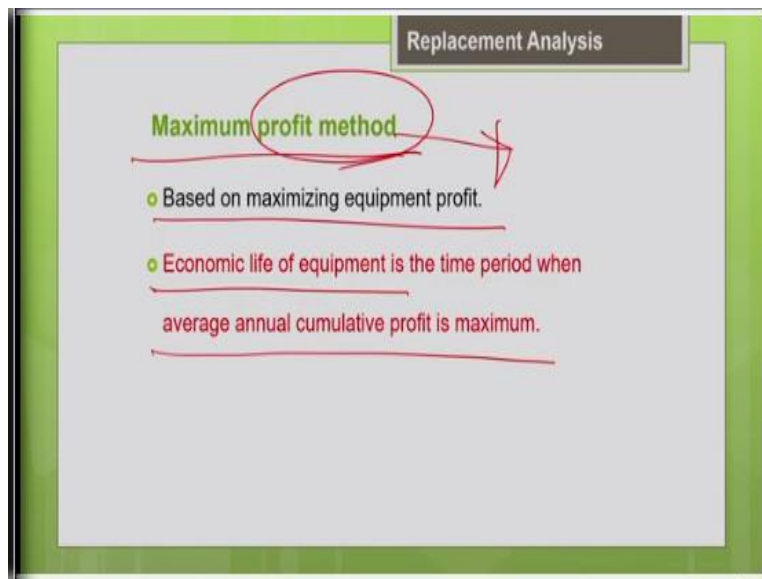
Now let us look into the next approach given by Dr. Douglas, it is nothing but maximum profit method. So, this is based on maximizing the equipment profit, so here we are optimizing the prediction with respect to profit. So, how to defend economic life here, it is a time period when the average annual cumulative profit is maximum. So, actually this is more attractive from business point of view because profit is always a bottom line of any company.

But to implement this method, you should have the data on the profit of the individual equipment**.** You should be able to extract the profit of the individual equipment from the equipment fleet or the entire project. In that case you will be able to use these guidelines, do the replacement analysis.

(Refer Slide Time: 29:13)

Average annual cumulative profits of the current loaders (Defender)

End of Year (1)	Annual Revenue ₹ (2)	Annual Cost ₹ (3)	Annual Profit ₹ (4)=(2)-(3)	Cumulative Profit ₹ (5)	Average Annual Cumulative Profit ₹ (6)=(5)/(1)
Revenue is ₹ 28,00,000 and decreases by ₹ 70,000 per year					
1	28,00,000.00	22,40,000.00	5,60,000.00	5,60,000.00	5,60,000.00
2	27,30,000.00	19,04,000.00	8,26,000.00	13,86,000.00	6,93,000.00
3	26,60,000.00	17,34,400.00	9,25,600.00	23,11,600.00	7,70,533.33
4	25,90,000.00	16,64,640.00	9,25,360.00	32,36,960.00	8,09,240.00
5	25,20,000.00	16,54,784.00	8,65,216.00	41,02,176.00	8,20,435.20
6	24,50,000.00	16,80,870.40	7,69,129.60	48,71,305.60	8,11,884.27
7	23,80,000.00	17,28,522.24	6,51,477.76	55,22,783.36	7,88,969.05
8	23,10,000.00	17,89,113.34	5,20,886.66	60,43,670.02	7,55,458.75
9	22,40,000.00	18,57,468.01	3,82,531.99	64,26,202.01	7,14,022.45
10	21,70,000.00	19,30,480.80	2,39,519.20	66,65,721.21	6,66,572.12

Maximum average annual cumulative profit of current loader is ₹ 8,20,435.20 (at end of fifth year)

So, now let us workout the same problem using maximum profit method. So, we are going to find the average annual cumulative profit of the current loader as well as the proposed loader. Now as given in the question, the revenue for the current loader is 28 lakh, it decreases by 70,000 every year. So, if you know as a machine age increases, you can see its productivity will be less, it is operating cost will be very high, it keeps increasing.

So, you can see there will be loss in revenue, so the revenue keep decreasing by 70,000 every year. To start with for the first year it is 28 lakh then the revenue is decreasing by 70,000 every year. So, subtract 70,000 you will get the revenue for the second year that is 27,30,000. Now again subtract the 70,000 to give the revenue for the third year, it is nothing but 26,60,000.

So, it keep deducting 70,000 for every year you will get the revenue for the annual revenue for every year. So, already we have estimated the annual cost by adding the operating and the maintenance cost and the depreciation in the earlier tables itself. You can use those values for the annual cost of the current loader. Now we are going to find the actual profit to determine the profit we have to subtract the cost from the revenue, then only we will get the annual profit. So, you are going to subtract column 2 minus column 3, that will give you the annual profit. So, how are you going to do it for the first year?

(Refer Slide Time: 31:00)

Average annual cumulative profits of the current loaders (Defender)

End of Year (1)	Annual Revenue ₹ (2)	Annual Cost ₹ (3)	Annual Profit ₹ (4)=(2)-(3)	Cumulative Profit ₹ (5)	Average Annual Cumulative Profit ₹ (6)=(5)/(1)
Revenue is ₹ 28,00,000 and decreases by ₹ 70,000 per year					
1	28,00,000.00	22,40,000.00	5,60,000.00	5,60,000.00	5,60,000.00
2	27,30,000.00	19,04,000.00	8,26,000.00	13,86,000.00	6,93,000.00
3	26,60,000.00	17,34,400.00	9,25,600.00	23,11,600.00	7,70,533.33
4	25,90,000.00	16,64,640.00	9,25,360.00	32,36,960.00	8,09,240.00
5	25,20,000.00	16,54,784.00	8,65,216.00	41,02,176.00	8,20,435.20
6	24,50,000.00	16,80,870.40	7,69,129.60	48,71,305.60	8,11,884.27
7	23,80,000.00	17,28,522.24	6,51,477.76	55,22,783.36	7,88,969.05
8	23,10,000.00	17,89,113.34	5,20,886.66	60,43,670.02	7,55,458.75
9	22,40,000.00	18,57,468.01	3,82,531.99	64,26,202.01	7,14,022.45
10	21,70,000.00	19,30,480.80	2,39,519.20	66,65,721.21	6,66,572.12

Maximum average annual cumulative profit of current loader is ₹ 8,20,435.20 (at end of fifth year)

Annual profit of first year = 28,00,000-22,40,000 = 5,60,000 rupees

Annual profit of second year = 27,30,000-19,04,000 = 8,26,000 rupees

So, you keep calculating, it for all the years, you have to subtract column 3 from column 2, so that you can get actual profits alone for every year.

(Refer Slide Time: 32:00)

Average annual cumulative profits of the current loaders (Defender)

End of Year (1)	Annual Revenue ₹ (2)	Annual Cost ₹ (3)	Annual Profit ₹ (4)=(2)-(3)	Cumulative Profit ₹ (5)	Average Annual Cumulative Profit ₹ (6)=(5)/(1)
Revenue is ₹ 28,00,000 and decreases by ₹ 70,000 per year					
1	28,00,000.00	22,40,000.00	5,60,000.00	5,60,000.00	5,60,000.00
2	27,30,000.00	19,04,000.00	8,26,000.00	13,86,000.00	6,93,000.00
3	26,60,000.00	17,34,400.00	9,25,600.00	23,11,600.00	7,70,533.33
4	25,90,000.00	16,64,640.00	9,25,360.00	32,36,960.00	8,09,240.00
5	25,20,000.00	16,54,784.00	8,65,216.00	41,02,176.00	8,20,435.20
6	24,50,000.00	16,80,870.40	7,69,129.60	48,71,305.60	8,11,884.27
7	23,80,000.00	17,28,522.24	6,51,477.76	55,22,783.36	7,88,969.05
8	23,10,000.00	17,89,113.34	5,20,886.66	60,43,670.02	7,55,458.75
9	22,40,000.00	18,57,468.01	3,82,531.99	64,26,202.01	7,14,022.45
10	21,70,000.00	19,30,480.80	2,39,519.20	66,65,721.21	6,66,572.12

Maximum average annual cumulative profit of current loader is ₹ 8,20,435.20 (at end of fifth year)

So, similarly, you have to find the cumulative profit by adding the profit of all the years you can get the cumulative profit. Now the average annual cumulative profit, so that is going to be the nothing but your cumulative profit divided by cumulative usage of the machine, that gives you the average annual cumulative profit.

$$\text{Average annual cumulative profit, first year} = \frac{5,60,000}{1} = 5,60,000 \text{ rupees}$$

$$\text{Average annual cumulative profit, second year} = \frac{13,86,000}{2} = 6,93,000 \text{ rupees}$$

Similarly calculate the profit for the third year, so for the third year, the annual cumulative profit is

$$\text{Average annual cumulative profit, third year} = \frac{23,11,000}{3} = 7,70,533.33 \text{ rupees}$$

So, this is how you have to estimate based on the maximum profit method. So, now the same way you can find economic life, so the year is which the profit is maximum that is an economic life. Here also you can see a kind of parabolic trend, so you can see initially the profit is low.

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Average annual cumulative profits of the current loaders (Defender)

End of Year (1)	Annual Revenue ₹ (2)	Annual Cost ₹ (3)	Annual Profit ₹ (4)=(2)-(3)	Cumulative Profit ₹ (5)	Average Annual Cumulative Profit ₹ (6)=(5)/(1)
Revenue is ₹ 28,00,000 and decreases by ₹ 70,000 per year					
1	28,00,000.00	22,40,000.00	5,60,000.00	5,60,000.00	5,60,000.00
2	27,30,000.00	19,04,000.00	8,26,000.00	13,86,000.00	6,93,000.00
3	26,60,000.00	17,34,400.00	9,25,600.00	23,11,600.00	7,70,533.33
4	25,90,000.00	16,64,640.00	9,25,360.00	32,36,960.00	8,09,240.00
5	25,20,000.00	16,54,784.00	8,65,216.00	41,02,176.00	8,20,435.20
6	24,50,000.00	16,80,870.40	7,69,129.60	48,71,305.60	8,11,884.27
7	23,80,000.00	17,28,522.24	6,51,477.76	55,22,783.36	7,88,969.05
8	23,10,000.00	17,89,113.34	5,20,886.66	60,43,670.02	7,55,458.75
9	22,40,000.00	18,57,468.01	3,82,531.99	64,26,202.01	7,14,022.45
10	21,70,000.00	19,30,480.80	2,39,519.20	66,65,721.21	6,66,572.12

Maximum average annual cumulative profit of current loader is ₹ 8,20,435.20 (at end of fifth year)

Now the profit is increasing, the profit reaches a maximum point here after that it starts decreasing. So, you can say the trend is like this, the profit increases the maximum increases, and reaches a maximum point and then again starts decreasing, so you are getting a trend like this. So, now you can find the time period during which a profit is maximum, that is your economic life, so that is happening in the 5th year for the current loader.

So, the maximum profit we are getting at the 5th year. So, it means that if you are holding this machine for 5 years with you. So, for the first five years, the average annual profit for the past five years will be 8,20,435.2. So, this is the economic life for the current loader based on maximum

profit method. Now we are going to compare it with the challenger. So, we have to estimate all these which are profits again for the challenger.

So, one thing you have to note it here is when you estimate based on the minimum cost method, the economic life was different. For the defender, hope you remember the economic life was 8 year based on minimum cost approach. Based on maximum profit approach, you can see the economic life is 5th year. So, different approaches gives you different view of the time of replacement.

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Average annual cumulative profits of proposed loaders (Challenger)

End of year (1) Revenue is ₹ 98,00,000 and decreased by ₹ 70,000 per year	Annual Revenue ₹ (2)	Annual Cost (3) (₹)	Annual Profit (4=(2)-(3)) (₹)	Cumulative Profit (5) (₹)	Average annual cumulative profit (6)=(5)/(1) (₹)
1	28,00,000.00	23,20,000.00	4,80,000.00	4,80,000.00	4,80,000.00
2	27,30,000.00	19,32,000.00	7,98,000.00	12,78,000.00	6,39,000.00
3	26,60,000.00	17,23,200.00	9,36,800.00	22,14,800.00	7,38,266.67
4	25,90,000.00	16,21,920.00	9,68,080.00	31,82,880.00	7,95,720.00
5	25,20,000.00	15,85,152.00	9,34,848.00	41,17,728.00	8,23,545.60
6	24,50,000.00	15,87,091.20	8,62,908.80	49,80,636.80	8,30,106.13
7	23,80,000.00	16,12,254.72	7,67,745.28	57,48,382.08	8,21,197.44
8	23,10,000.00	16,51,352.83	6,58,647.17	64,07,029.25	8,00,878.66
9	22,40,000.00	16,98,811.70	5,41,188.30	69,48,217.55	7,72,024.17
10	21,70,000.00	17,51,287.02	4,18,712.98	73,66,930.53	7,36,693.05

Maximum average annual cumulative profit of new loaders is ₹ 8,30,106.13 (at end of Sixth year).

Now let us calculate the average annual cumulative profit for the proposed loader that is challenger**.** The revenue is same, so the same way you are going to calculate the revenue, every year the revenue is decreasing by 70,000 per year, so you can calculate. The annual cost is already calculated for the proposed loader from the previous table you can take these values**.** Now your profit is nothing but your revenue minus cost column 2 minus column 3 that is going to give you the profit.

The same way you can calculate and then you find the cumulative profit so find the cumulative profit. Now we are going to find the average annual cumulative profit which is nothing but the cumulative profit divided by the usage.

$$\text{Average annual cumulative profit, first year} = \frac{4,80,000}{1} = \text{4,80,000 rupees}$$

Average annual cumulative profit, second year $= \dfrac{12,78,000}{2} = 6,39,000$ **rupees**

So, now you can again determine the economic life for your proposed loader. So, proposed loader you can see the profit is increasing with the time. So, you are getting a trend like this.

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Average annual cumulative profits of proposed loaders (Challenger)

End of year (1)	Annual Revenue ₹ (2) Revenue is ₹ 28,00,000 and decreases by ₹ 70,000 per year	Annual Cost (3) (₹)	Annual Profit (4=(2)-(3)) (₹)	Cumulative Profit (5) (₹)	Average annual cumulative profit (6)=(5)/(1) (₹)
1	28,00,000.00	23,20,000.00	4,80,000.00	4,80,000.00	4,80,000.00
2	27,30,000.00	19,32,000.00	7,98,000.00	12,78,000.00	6,39,000.00
3	26,60,000.00	17,23,200.00	9,36,800.00	22,14,800.00	7,38,266.67
4	25,90,000.00	16,21,920.00	9,68,080.00	31,82,880.00	7,95,720.00
5	25,20,000.00	15,85,152.00	9,34,848.00	41,17,728.00	8,23,545.60
6	24,50,000.00	15,87,091.20	8,62,908.80	49,80,636.80	8,30,106.13
7	23,80,000.00	16,12,254.72	7,67,745.28	57,48,382.08	8,21,197.44
8	23,10,000.00	16,51,352.83	6,58,647.17	64,07,029.25	8,00,878.66
9	22,40,000.00	16,98,811.70	5,41,188.30	69,48,217.55	7,72,024.17
10	21,70,000.00	17,51,287.02	4,18,712.98	73,66,930.53	7,36,693.05

Maximum average annual cumulative profit of new loaders is ₹ 8,30,106.13 (at end of Sixth year).

Your profit is increasing and at the particular point it reaches the maximum, then again it starts reducing with the duration with the age of the machine. So, the duration for which your profit is maximum that is your economic life. So, you can see it is increasing reaches the maximum point, this is a maximum point after that it starts again decreasing. So, this is the economic life for your challenger 6th year. So, hope you remember based on minimum cost method, we found the economic life as 9th year based on minimum cost method.

But based on maximum profit method for the proposed loader, that is a challenger the economic life is your 6th year, because the profit is maximum at the 6th year. Another thing you have to compare here is what is the maximum profit for the current loader and the propose loader. So, the maximum average annual cumulative profit is 8,20,435, here it is 8,30,106.13, that means the profit is maximum for the challenger.

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Average annual cumulative profits of proposed loaders (Challenger)

End of year (1)	Annual Revenue ₹ (2)	Annual Cost (3) (₹)	Annual Profit (4=(2)-(3)) (₹)	Cumulative Profit (5) (₹)	Average annual cumulative profit (6)=(5)/(1) (₹)
Revenue is ₹ 28,00,000 and decreases by ₹ 70,000 per year					
1	28,00,000.00	23,20,000.00	4,80,000.00	4,80,000.00	4,80,000.00
2	27,30,000.00	19,32,000.00	7,98,000.00	12,78,000.00	6,39,000.00
3	26,60,000.00	17,23,200.00	9,36,800.00	22,14,800.00	7,38,266.67
4	25,90,000.00	16,21,920.00	9,68,080.00	31,82,880.00	7,95,720.00
5	25,20,000.00	15,85,152.00	9,34,848.00	41,17,728.00	8,23,545.60
6	24,50,000.00	15,87,091.20	8,62,908.80	49,80,636.80	8,30,106.13
7	23,80,000.00	16,12,254.72	7,67,745.28	57,48,382.08	8,21,197.44
8	23,10,000.00	16,51,352.83	6,58,647.17	64,07,029.25	8,00,878.66
9	22,40,000.00	16,98,811.70	5,41,188.30	69,48,217.55	7,72,024.17
10	21,70,000.00	17,51,287.02	4,18,712.98	73,66,930.53	7,36,693.05

Maximum average annual cumulative profit of new loaders is ₹ 8,30,106.13 (at end of Sixth year).

So, when you compare the maximum average annual cumulative profits, it justifies that your challenger is generating more profit. So, if you are going to hold it for 6 years so you are able to realize a maximum profit of 8,30,000 for the past 6 years. So, basically it is preferable to replace your old machine with the new machine, that is what is the decision. When to replace? We will go by the guides by Dr. James Douglas.

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Replacement Analysis

Maximum profit method

- Decision to replace equipment is made when estimated annual profit of defender for next year falls below maximum average annual cumulative profit of challenger.
- Estimated annual profit of current loaders, ₹ 8,26,000.00 (in the second year) falls below ₹ 8,30,106.13 of new loaders.
- Hence loaders should be replaced immediately.

So, the decision to replace the equipment is made, when the estimated annual profit of defender for the next year falls below the maximum average annual cumulative profit of the challenger. So, we are going to calculate the see what is the estimated annual profit of the defender for the next

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year. So, basically, your current loader is already 1 year old, so the next year means for the second year what is the estimated annual profit?

Estimated annual profit of your current loader is 8,26,000. Now you compare this value with the maximum profit achieved by a challenger, maximum profit, so 8,30,806. So, the estimated annual profit of the current loader is 8,26,000, in the second year this is very much less when compared to the this is lesser when compared to the new loader that is this value is nothing but your annual average the profit of your proposed loader.

So, you compare the estimated annual profit of the current loader with the average annual that is the maximum average annual profit of your the proposed loader. So, this profit is falling below this, the current loader profit is falling below this, that is why we have to replace the loader immediately, so this is a decision based upon your maximum profit method. So, in the minimum cost method, hope you remember how we made the decision.

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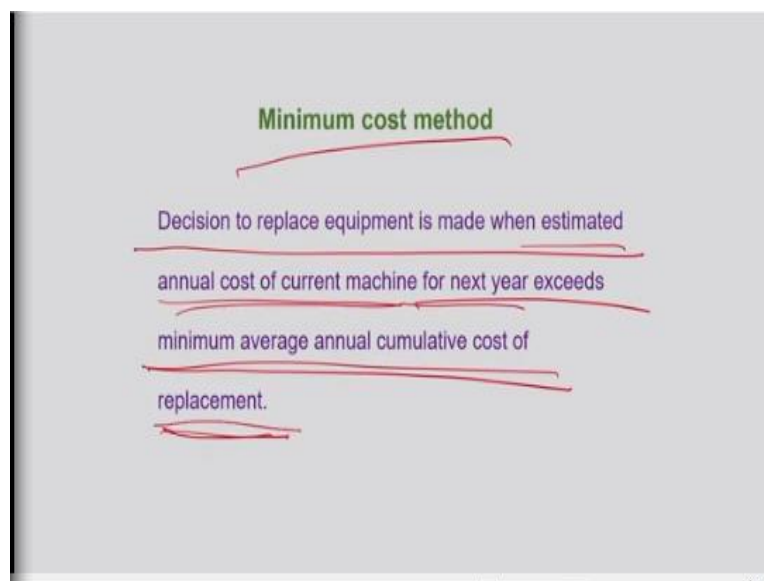
So, we are comparing the annual cost of the current machine of the next year with the minimum average annual cumulative cost of the replacement. So, if the annual cost of the current machine for the next year exceeds the minimum average annual cumulative cost of your proposed machine, then you have to replace.

In a similar perspective here you can see that in the maximum profit method, if the annual profit of the current loader for the next year falls below the maximum average annual the cumulative profit for the new loader, in that case we have to justify the replacement. So, this as per the guidelines of Dr. James Douglas, we have to replace the current loader with the new loader.

So, the challenger is found to be more economical and the replacement has to be done immediately, so that is what is the output of this analysis. But based on intuitive method, we can find that we are not able to work it out in a more rational way. So, hence the intuitive method can be use in addition with the other methods like minimum cost method or maximum profit method to present a different view of the replacement analysis.

So, solely we cannot depend upon the intuitive method, there is one more method which was discussed by Dr. James Douglas, that is payback period method. In this method we are going to find the time, payback time for the defender and the challenger, you are finding the payback time. **(Refer Slide Time: 40:54)**

Payback time is nothing but the time duration needed for a machine to recover the initial investment you are putting to the machine. So for every machine you know that you have invested some amount of money, there may be some huge investment in the machine that is a the purchase price of the machine. So, how much time it takes for you to recover that initial investment, what you are made in the machine.

That is nothing but your payback period by generating the profit. So, how much time is needed for the machine to recover the initial investment made in the machine by generating the profit?. So, that is what we are finding in the payback period method and you will compare the payback period value of the defender and the challenger. So, defender versus challenger, you can compare the payback period.

So, whichever the machine has a lower payback period, that means if you are able to recover the initial cost faster, so that machine is suitable. So, that is how we compare based on the payback period method. So, if say for example of the challenger gives you a shorter payback period when compared to the defender then we have to replace the defender with the challenger. Whichever is having shorter payback period, we have to go for that machine.

So, that is how we compare alternatives, this is also not very much rational when compared to the minimum cost method or maximum profit method. Because in this method, we are not looking into what is happening beyond payback time beyond the payback period, what is actually happening, we are not analyzing in detail. So, that is why we cannot solely depend upon this method, payback period method.

We have to do compare the conclusion achieved by this method along with any other method like a maximum profit method or minimum cost method. So, you can use it in combination with the other methods and compare the replacement analysis decision. So, the best approach is your minimum cost method and the maximum profit method. Other methods like intuitive method or the payback period method; you can use it in combination with the other methods to have a comparison of different replacement decisions. Now let me summarize what we have discussed so far in this lecture.

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Replacement Analysis

Summary

o Intuitive method acts like baseline for comparison with other methods.

o Minimum cost method focus on replacing equipment when overall cost is minimum.

o Maximum profit method provides a model for profit making enterprise to make decision with profit on bottom line.

o The above method is approximate as it does not consider time value of money.

o Using compounding factors determine minimum equivalent uniform annual cost of defender and challenger.
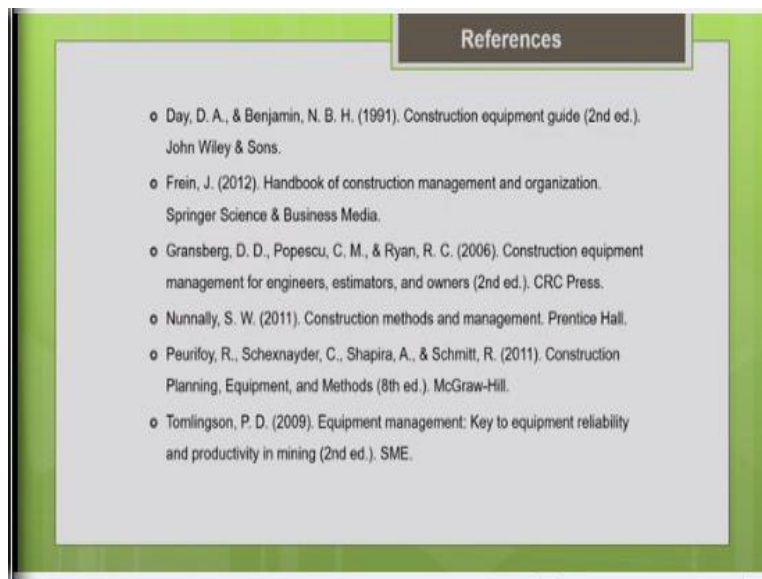
So, the intuitive method is acting like a baseline for comparison with the other methods. As I told you it is just a decision what we make based upon our professional experience or based on the common sense, we can just make a decision without working the economics in detail. So, like we are not using any theoretical model or analytical model to work it out. So, that is why you can use this method in comparison with other approaches.

Then minimum cost method focus on replacing your equipment when the overall cost is minimum. And the maximum profit method provides a model for profit making enterprise particularly for the companies who main objective is only to make profit. So, those companies they can use the maximum profit method. But provided they should be able to extract the profit of the individual equipment from the entire project, then only they can do the analysis.

So, and one thing we have to note it here as I mentioned in the earlier lecture also, here we are not considering the timing of the cash flows. That is why the analysis what we have done so far it is only approximate, because we have not considered the timing of cash flows. So, in the next lecture, what we are going to do is, we will consider the timing of cash flows, we will convert the cash flows which are occurring at different time interval into equivalent cash flows at the particular time period and make the comparison.

So, using the various component factors, what we were discussing earlier lectures. So, using component factors, we will determine minimum equivalent uniform annual cost of defender and challenger and make the comparison and do the replacement analysis. That will give you with the accurate estimate. So, this method is going to be more accurate when compared to the previous methods whatever we have discussed so far. So, the next lecture we are going discuss the replacement analysis using the time value concept.

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So, these are the references which I have referred for this lecture. So, you can go through this textbooks to prepare the topics related to this lecture, so let us meet in the next lecture, thank you.