So, now we have to find the equivalent annual cost for the third year of the purchase price 3500000 for year 3,

$$USCRF = \frac{A}{(3500000, 0.15, 3)} = \frac{i(1+i)^n}{(1+i)^n - 1} = \frac{0.15(1+0.15)^3}{(1+0.15)^3 - 1} = 0.4380$$

$$EAC = 0.4380 \times 35,00,000 = 15,33,000 \text{ rupees}$$

So like this you are going to calculate for all the years. Now let us find the equivalent annual cost of the operating and the maintenance cost. So, how to find the equivalent annual cost let us go back to the cash flow diagram. So, this 1,13,200 is operating and maintenance cost at the end of year 1. Now you convert it into t = 0, how to convert it into t = 0, find the present worth?

So, find the present worth of 1,13,200, so that is a first step. Once you find the present worth of 1,13,200 then you can find it is equivalent annual cost using uniform series capital recovery factor. So, the first step is we will find the present worth of the operating and the maintenance cost, so for that you have to go for the present worth factor.

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So, we are going to find the present worth of 1,13,200 that is your operating cost. So, you need to find P for the known F, i, n,

$$\text{P.W} = \frac{P}{113200, 0.15, 1} = \frac{1}{(1+0.15)^1} = 0.8696$$

This present worth factor you multiply it by the operating and maintenance cost

Present worth value = 0.8696 × 1,13,200 = 98,438.72 rupees

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So, like this you are going to calculate the present worth of all the operating and maintenance cost.

So, let us workout for one more trail, so that you will understand better.

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So, this is your operating and maintenance cost, we are going to find the present worth of 2,83,500,

$$P.W = \frac{P}{283500,0.15,2} = \frac{1}{(1+0.15)^2} = 0.7561$$

Present worth value = 0.7561 × 2,83,500 = 2,14,354 rupees

So, this is how you have to calculate the present worth of the operating and maintenance cost. So, like this you are going to find the present worth factor for all the years and multiply the present worth factor by the operating and maintenance cost and we will get the present worth of the operating and maintenance cost for all the years. Now you add the cumulative, so find the cumulative operating and maintenance cost. So, now, next thing is we are going to find the equivalent annual cost of the present worth of the operating and maintenance cost so how to calculate that?

So, now you have found the present value of your operating and maintenance cost, you have to find it is equivalent value, so go for the uniform series capital recovery factor. So, that means you are going to find A for the given P, i, n, what is a known P? P is nothing but your the present value is 98,438.72, interest rate is 0.15, n is 1. So, now we are going to find the A, equivalent A for this P, so how to do that?

$$USCRF = \frac{A}{(98438.72,0.15,1)} = \frac{i(1+i)^n}{(1+i)^n-1} = \frac{0.15(1+0.15)^1}{(1+0.15)^1-1} = 1.15$$

So, this factor you multiply it by the operating and the maintenance cost present value that is 98,438.72.

EAC of O&M cost = 1.15 × 98,438.72 = 1,13,204.53 rupees

So, this is an equivalent annual cost of the present worth of operating and maintenance cost for the year 1, this is for the year 1. Let us calculate for one more year.

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So now we are going to calculate the equivalent annual cost of the present worth of operating and maintenance cost for year 2. So, it is nothing but your you know the present worth of the operating and maintenance cost, you are going to find the A for the known P, i, n.

$$\text{USCRF} = \frac{A}{(312793.07,0.15,2)} = \frac{i(1+i)^n}{(1+i)^n - 1} = \frac{0.15(1+0.15)^2}{(1+0.15)^2 - 1} = 0.6151$$

EAC of O&M cost for year 2 = 0.6151 × 3,12,793.07 = 1,92,399.02 rupees

This is my equivalent annual cost of the present worth of the operating and maintenance cost. Similarly, you can calculate it for the third year, third year you know, already we have estimated the capital recovery factors for different years.

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Economic life using EAC

$$\frac{P}{F,i,n} = \frac{1}{(1+i)^n} \qquad \frac{A}{P,i,n} = \frac{i(1+i)^n}{(1+i)^n - 1}$$

Year	PW of O&M cost	Cumulative O&M cost	EAC of PW of O&M cost
(1)	(6) = (4) x (5)	(7)	(8) = (7) x (2)
1	98,438.72	98,438.72	1,13,204.53
2	2,14,354.35	3,12,793.07	1,92,399.02
3	2,25,522.50	5,38,315.57	2,35,782.22
4	2,18,770.68	7,57,086.25	2,65,207.31
5	2,34,330.36	9,91,416.61	2,95,739.57
6	2,23,412.64	12,14,829.25	3,20,957.89
7	2,49,973.50	14,64,802.75	3,52,138.58
8	2,39,879.22	17,04,681.97	3,79,973.61

(handwritten: EAC of O&M cost year 3; 0.4380 X 5,38,315.57 = 2,35,782.22)

So, now let us calculate the equivalent annual cost of operating and maintenance cost for the third year, year 3. So, already you know the capital recovery factor we have the value, it is 0.4380

EAC of O&M cost for year 3 = 0.4380 × 5,38,315.57 = 2,35,782.22 rupees

So, like this you are going to calculate the equivalent annual cost for all for the entire useful life of the machine.

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Economic life using EAC

$$\frac{P}{F,i,n} = \frac{1}{(1+i)^n} \qquad \frac{A}{P,i,n} = \frac{i(1+i)^n}{(1+i)^n - 1}$$

Year	Predicted resale value	PW of resale value	EAC of PW resale value	EAC of purchase, O&M, Salvage
(1)	(9)	(10) = (9) x (5)	(11) = (10) x (2)	12 = (3) + (8) − (11)
1	31,50,000.00	27,39,240.00	31,50,126.00	9,88,078.53
2	29,50,000.00	22,30,495.00	13,71,977.47	9,73,271.55
3	28,00,000.00	18,41,000.00	8,06,358.00	9,62,424.22
4	24,50,000.00	14,00,910.00	4,90,738.77	10,00,518.54
5	20,00,000.00	9,94,400.00	2,96,629.52	10,43,160.05
6	14,00,000.00	6,05,220.00	1,59,899.12	10,85,758.77
7	10,50,000.00	3,94,695.00	94,884.68	10,98,653.90
8	7,00,000.00	2,28,830.00	51,006.21	11,09,117.40

(handwritten: PW of 31,50,000;
$$\frac{P}{F,i,n} = \frac{P}{31,50,000, 0.15, 1}$$
$$= \frac{1}{(1+i)^n} = \frac{1}{1.15} = 0.8696$$
$$= 0.8696 \times 31,50,000 = 27,39,240\,)$$

Now let us find the equivalent annual cost of the resale value, that is your salvage value. So, let us go back to the cash flow diagram. So, now what you are going to do is, this is the salvage value which is occurring at the end of year 1. So, you can directly convert into a equivalent annual cost

using uniform series sinking fund factor or the another method is you find it is present value, you convert this future cash flow into t = 0, convert it into t = 0 using present worth factor.

Then again, we have distributed or converted into equivalent annual cost using capital recovery factor, so either of these approaches you can use. So, now we are going to follow the second approach whatever I discussed just now. So, what we are going to do here is, first calculate the present value of the resale value. So, how to find the present value of the present value? Present value of your resale value 31,50,000, so use the present worth factor.

$$P.W = \frac{P}{3150000, 0.15, 1} = \frac{1}{(1+0.15)^1} = 0.8696$$

Present worth value = 0.8696 × 31,50,000 = 27,39,240 rupees

So, similarly you calculate the present worth for the year 2.

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$$P.W = \frac{P}{2950000, 0.15, 2} = \frac{1}{(1+0.15)^2} = 0.7561$$

Present worth value = 0.7561 × 29,50,000 = 22,30,495 rupees

So, this is how you have to calculate the present worth of the resale values which are occurring at different time period. Let us calculate for one more year, so that you will have a better understanding.

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Economic life using EAC

So, the present worth of resale value for year 3 is nothing but,

$$\text{P.W} = \frac{P}{2800000, 0.15, 3} = \frac{1}{(1+0.15)^3} = 0.6575$$

Present worth value = 0.6575 × 28,00,000 = 18,41,000 rupees

So, this is how you have to calculate for all the years. So this is how you have to calculate for all the years. So, you have supposed to find the equivalent annual cost of the present value, you have converted the future resale values or the salvage value to time = 0 by using the present worth factor. Now you are going to convert into equivalent annual cost using uniform series capital recovery factor.

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Economic life using EAC

So, that means, so we are going to find the equivalent annual cost of the resale value, so how find that? So, equivalent annual cost of your present worth of the resale value is 27,39,240 for this we have to find the equivalent annual cost, so we need to find A for the given P, i, n.

$$\text{USCRF} = \frac{A}{(2739240, 0.15, 1)} = \frac{i(1+i)^n}{(1+i)^n - 1} = \frac{0.15(1+0.15)^1}{(1+0.15)^1 - 1} = 1.15$$

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EAC of resale value for year 1 = 1.15 × 27,39,240 = 31,50,126 rupees

So, this is how you have to find equivalent annual cost for the resale value at the end of year 1. So, one more year we will work out for the resale value.

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So, a equivalent annual cost of resale value at the end of year 2, so how to find that? So, we are going to find A for the given P, i, n, what is P? P is nothing but your present worth of the resale value 22,30,495,

$$\text{USCRF} = \frac{A}{(2739240, 0.15, 1)} = \frac{i(1+i)^n}{(1+i)^n - 1} = \frac{0.15(1+0.15)^1}{(1+0.15)^1 - 1} = 1.15$$

EAC of resale value for year 1 = 1.15 × 27,39,240 = 31,50,126 rupees

interest rate is 0.15, year is 2. So, now we find the factor, already we have determined the factor, factor is nothing but 0.6151.

EAC of resale value for year 2 = 0.6151 × 22,30,495 = 13,71,977.47 rupees

So, 0.6151 is a factor multiply by 22,30,495. So, this gives me the equivalent annual cost of the resale value as 13,71,977.47. Similarly, for the year 3 you can find the year 3.

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Year 3, it is going to be 3. So, here the factor will be different, what is the factor? 0.4380,

EAC of resale value for year 3 = 0.4380 × 18,41,000 = 8,060358 rupees

So, this is how you have to estimate the equivalent annual cost of resale value for the different years. So, first convert the resale value into the present worth using the present worth factor, then multiply it by the uniform series capital recovery factor.

So, that you can get the equivalent annual cost the resale value for different time periods. So, now we have estimated the equivalent annual cost of the purchase price, you have estimated the equivalent annual cost of the operating and maintenance cost and you have estimated the

equivalent annual cost of the salvage value. So, now you can find the total cost. So, how to find the total cost?

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So, you are supposed to add the purchase price and the operating and maintenance cost, your salvage value is in flow cash inflow, so you subtract it. So, what is your equivalent annual cost of the purchase price for the year 1? Equivalent annual cost of the purchase price is 40,25,000 you add it with the equivalent annual cost of the operating and maintenance cost.

EAC of purchase price, O&M, salvage value=40,25,000+1,13,204.53–31,50,126 = 9,88,078.53

So, what are we doing actually here? You are adding the purchase price equivalent annual cost of the purchase price and the operating and maintenance cost.

And you are deducting the cash in-flow, that is your salvage value and you will get the total cost 9,88,078.53. So, like this you are going to find the equivalent annual cost for all the years. So, let me summarize how we have done this table. So, first I have tabulated the uniform series capital recovery factor in the second column you can see. Now I am calculating the equivalent annual cost of the purchase price.

How to calculate the equivalent cost of the purchase price? You know the capital recovery factor multiplied by the purchase price. The capital recovery factor is column number 2 multiplied by the purchase price 35,00000 that gives the column number 3. Now you find the equivalent annual cost

of the operating and maintenance cost. So, the operating and maintenance cost are occurring at different time periods converted into time $t = 0$.

So, for that I need to find the present worth, how to find the present worth? Use the present worth factor, these are the present worth factors calculated for different years. So, multiply this present worth factor with the operating and the maintenance cost, you multiply both, column 4 multiplied by column 5 will give you the present worth of the operating and maintenance cost that is column 6.

So, now you find the cumulative operating and maintenance cost, add everything. Now your column 8 will be equivalent annual cost of the present worth of the operating and maintenance cost, how to find that? You know the present value of your operating and maintenance cost, you multiply this column by the uniform series capital recovery factor, that is column number 2. So, multiply this present value with the uniform series capital recovery factor column number 2. So, column 7 multiplied by column 2 gives you the equivalent annual cost of the operating and maintenance cost.

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Now your resale value. So, resale value is a column 9, now if converted into time $t = 0$ by using the present worth factor. So, which is the present worth factor column? Present worth factor column is column number 5. So, this column number 5, you multiply with column number 9, that

is resale- value, you will get the present worth of the resale value. Now find the equivalent annual cost, so how will you do that?

You multiply the present worth the column number 10 multiplied by the uniform series capital recovery factor which you have calculated for in column number 2. That will give you column number 11 equivalent annual cost of the resale value. Now the total equivalent annual cost, you add the purchase price, your cash outflow, operating and maintenance is a cash outflow, add it, and subtract the cash in-flow, that is a salvage value.

That gives you a total equivalent cost. So, now you can see that your cost is high in the initial stage then it reduces, reaches the minimum value then again starts increasing. After year 3, you can see that it is the reaching by minimum at the year 3 and after that it is increasing, why it is increasing significantly? Because of increase in maintenance and the repair cost. So, the economic life of this machine is third year, the optimum replacement time of this machine is third year.

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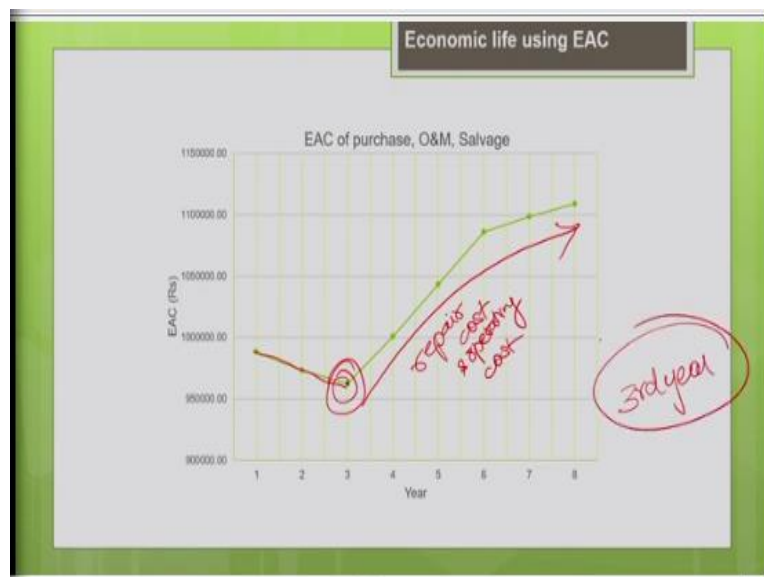
So, you can see the pictorial representation of the cost plotted. You can see it is reducing reaches a minimum at the time 3 and after that there is a significant increase in the cost. This increase will be due to the increase in the repair cost and the operating cost associated with the machine. Due to increase the age of the machine, that is way before the repair cost and operating cost increases

significantly you are supposed to replace the machine. So, the optimum replacement time of this machine or the economic life of the machine is 3rd year.

So, in this problem we have determined the economic life of the machine using the equivalent annual cost approach. Like we have converted all the cash flows which are occurring at different time period into a particular time period = 0.

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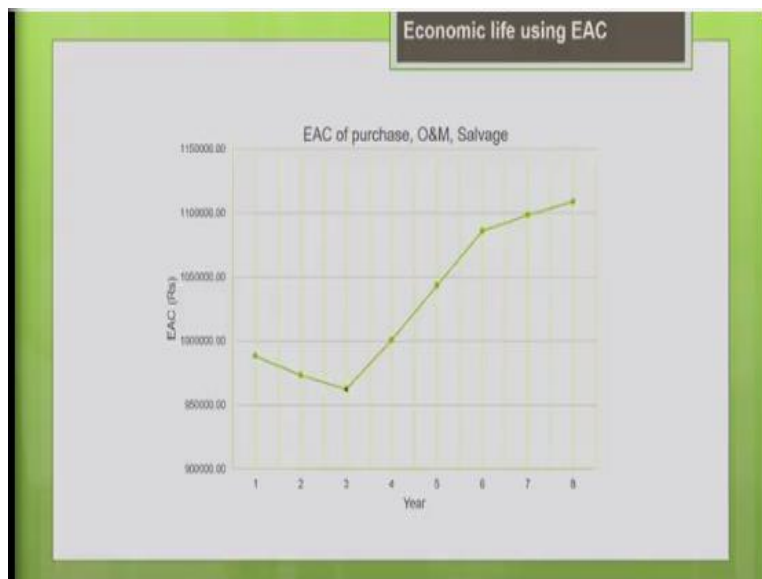
Then we converted into equivalent annual cost using the component factors. So, then we found out the time period during which the equivalent annual cost associated with the machine is minimum, that is the optimum time for the replacement of the machine. So, this is how we determine the economic life of the machine using equivalent annual cost approach.

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Defender vs Challenger

A construction firm has purchased a track mounted front shovel 4 years ago, at a cost of ₹ 35,00,000.

At the time of purchase, the machine was expected to last for 10 useful years and estimated salvage value of machine was ₹ 7,00,000. The machine is considered for replacement against a challenger whose initial cost is ₹ 27,50,000.

Due to depreciation, the current book value of the existing equipment is ₹ 23,80,000. The defender can be traded in today at ₹ 22,50,000.

The new estimates of salvage value and remaining life are ₹6,00,000 and 5 years respectively.

The annual operating and maintenance cost of existing asset is ₹ 1,35,000.

The challenger has annual operating cost of ₹ 90,000 and salvage value of ₹ 12,00,000 at end of 5 years. Investment cost is 10% per year.

Find out whether the defender should be retained or replaced with challenger by Time value (annual worth) method.

Now let us discuss about another replacement analysis problem in which we are going to compare the defender and the challenger. So, as you know defender is the current equipment and challenger is the proposed equipment. So, we are going to estimate the equivalent annual cost associated with the defender and we are going to compare it with the equivalent annual cost associated with the challenger. And then make a decision whether to replace the defender with the challenger or not.

So, that is what we are going to discuss in this upcoming problem. So, let us now workout this problem and try to understand. So, a construction firm has purchased a track mounted front shovel. So, the purchase price is 35,00,000, 4 years ago, so the construction firm has purchase this machine 4 years ago at the cost of 35,00,000, that time the purchase price was 35,00,000. So, at the time of purchase, the machine was expected to last for 10 useful years.

That means the useful life was estimated at the time of purchase to be 10 years, and the salvage value was estimated to be 7,00,000 after 10 years. The machine is now considered for replacement against the challenger whose initial cost is 27,50,000. Another important thing to be noted is due to depreciation, the current book value of the existing equipment is 23,80,000.

So, we have adopted some depreciation accounting method and we have estimated the current book value of the existing machine as 23,80,000 in your accounting records. But now, the actual trading value of the machine of the defender is 22,50,000. So, as I told you earlier in the

replacement analysis, we have to always look from third party perspective. So, like an outsider we have to look at the process and then make the decision.

So, the replacement analysis has to be done through outsider perspective as a third-party perspective. For an outsider, he is not bothered about your initial purchase price of the machine, this is totally irrelevant to him, this 35,00,000 is your initial purchase price, it is not important for an outsider. What he is concerned about is only the current trading value of the machine, the current trading value is 22,50,000.

So, when you sell in the market, what is the current market value or the trading value is 22,50,000, this is only your initial cost of the defender or you can say the first cost of the defender. The first cost of defender from third party or the outsider perspective. So, you have estimated book value of the machine using your depreciation accounting method in your accounting record as 23,80,000 but your current trading value is only 22,50,000.

So, the difference is your sunk cost, so this 23,80,000 minus 22,50,000, so this is your sunk cost. So, this is a cost which you are invested earlier but it cannot be recovered. Sunk cost is the cost which cannot be recovered in the future recovered in the past. So, basically the sunk cost is also irrelevant, it should be ignored or neglect this sunk cost in the replacement analysis. What we are concerned is only about this value, it is nothing but your market value or the current trading value of your existing machine.

Now, so let us look into what are all the other information available. Now the new estimates of the salvage value is 6,00,000.

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The new estimate is 6,00,000, but the old estimate was 7,00,000 that has to be ignored, you have to consider what is the new estimate. And the current estimate of the remaining life of the machine is 5 years. See based upon your earlier estimate, if we estimate the remaining life, see the total life of the machine was estimated to be 10 years.

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At the time of purchase, we have estimated the useful life of the machine was 10 years. So, now the remaining life is supposed to be 10 years minus 4 years is nothing but 6 years is the remaining life but it is not so. According to the new estimate the remaining life is only 5 years, you have to consider only this new estimate, you have to ignore this old estimate. So, the annual operating and the maintenance cost of the existing assert is 1,35,000.