Chapter 7 - Replacement Analysis

1 Overview

Defender: asset currently in service.

Challenger: an alternative asset.

Should a defender be replaced by a challenger?

The answer is based on EAC comparisons - a replacement should be made when the EAC of the challenger is lower than the defender's cost for the coming year and its EAC for its remaining service life.

Existing assets may be replaced due to deteriorating performance, obsolescence, or inadequate capacity.

2 Two Approaches

1. Consider the salvage value of the old asset to be the cost of keeping the defender in service: the capital cost of the no-change alternative.
2. Consider the defender's salvage value as a receipt (positive cash flow) that offsets part of the purchase price (negative cash flow) of each of the challengers. Then the net differences between the cash flows of the defender and each challenger are compared.

Example:

Year	Defender (D)	Challenger (C)	Difference (D-C)
0	$P = \$5000$	$P = \$7500$	$-\$2500$
1	1700	500	1200
2	2000	1100	900
3	2500	1300	1200

Service life = 3 years, MARR=12%. Suppose the market value of the defender is considered to be the cost of its continued service.

Solution:

$$\begin{aligned} EAC(D) &= [5000 + 1700(P/F, 12, 1) + 2000(P/F, 12, 2) + 2500(P/F, 12, 3)](A/P, 12, 3) \\ &= [5000 + 4892](0.41635) \\ &= \$4119 \end{aligned}$$

$$\begin{aligned} EAC(C) &= [7500 + 500(P/F, 12, 1) + 1100(P/F, 12, 2) + 1300(P/F, 12, 3)](A/P, 12, 3) \\ &= [7500 + 2249](0.41635) \\ &= \$4059 \end{aligned}$$

Since $EAC(C) < EAC(D)$, the defender should be replaced.

Note: $PW(D) = -\$9892$ and $PW(C) = -9749$, so a PW comparison gives the same conclusion.

Using the second approach:

$$\begin{aligned} EAC(D-C) &= [-2500 + 1200(P/F, 12, 1) + 900(P/F, 12, 2) + 1200(P/F, 12, 3)](A/P, 12, 3) \\ &= [-2500 + 2643](0.41635) \\ &= \$60 \end{aligned}$$

Since this is a positive value, the defender should be replaced.

Note: $EAC(D) - EAC(C) = 4119 - 4059 = \$60$.

Now suppose a second challenger competes with the defender. This challenger, F, has a purchase price of \$9000 but \$6000 is offered as a trade-in and the seller guarantees that operating costs will be no more than \$800 per year. Should the offer be accepted if the MARR is 12% and F has no salvage value at the end of its 3 year life?

Solution: Apply the discount \$6000-5000=\$1000 to the \$9000 first cost of F, reducing its effective price to \$8000. Then,

$$\begin{aligned} EAC(F) &= 8000(A/P, 12, 3) + 800 \\ &= 8000(0.41635) + 800 \\ &= \$4131 \end{aligned}$$

Since $EAC(F) > EAC(D) > EAC(C)$, the challenger is rejected.

3 Defender and Challenger with Different Lives

3.1 Study Period Method

The period of known need of an asset's service.

When Study Period $\leq$ Remaining Life of D and the challenger(s) have longer lives, the salvage values at the time of service termination must be estimated. Then use the formula

$$EAC = (P - S)(A/P, i, N) + iS$$

where N is the number of years in the study period.

3.2 Common Multiple Method

Assumes that an asset is replaced with an identical asset and that the asset's services are needed indefinitely.

Example (continued): Consider another challenger, G, with a first cost of \$12000 and a salvage value of \$2000 at the end of its 5 year life, and operating costs of \$700 per year. Services provided by the asset will be needed indefinitely and the MARR is 12%.

$$\begin{aligned} EAC(G) &= (12000 - 2000)(A/P, 12, 5) + (0.12)(2000) + 700 \\ &= 2774 + 240 + 700 \\ &= \$3714 \end{aligned}$$

Since $EAC(G) < EAC(D)$, replacement is advisable.

If an asset is to be replaced, the next question is <u>WHEN</u> to make the replacement.

Replacement takes place when the cost of one more year's service by the defender exceeds the EAC of the challenger.

Example (continued): Assume the defender D loses \$2000 in value from one more year of service. Then S=3000 at the end of the year

$$\begin{aligned} EAC(D_{OneYear}) &= (5000 - 3000)(A/P, 12, 1) + (0.12)(3000) + 1700 \\ &= \$4300 \end{aligned}$$

This exceeds the EAC(G), so the replacement should be made immediately.

4 Replacement Due to Deterioration

Excessive operating costs, increased maintenance costs, higher reject rates, etc.

Example: An existing machine is worth #2500 today and will lose $1000 in value by the next year and $500 per year thereafter. Its operating cost of $8000 this year is expected to increase by $1000 annually due to deterioration. It will be retired in 4 years when its salvage value will be zero. A new machine can be purchased for $16000 with operating costs of $6000 per year until the end of its 7 year economic life, at which time S=$1500. If the MARR is 12%, should be existing machine be replaced and, if so, when?

Solution:

$$EAC(C) = (16000 - 1500)(A/P, 12, 7) + (0.12)(1500) + 6000 = \$9357$$

$$EAC(D_{OneYear}) = (2500 - 1500)(A/P, 12, 1) + (0.12)(1500) + 8000 = \$9300$$

Since D has a lower EAC for the next year, it should be retained.

$$EAC(D_{YearTwo}) = (1500 - 1000)(A/P, 12, 1) + (0.12)(1000) + 9000 = \$9680$$

Since $\$9680 > EAC(C)$, the defender should be replaced one year from now.

5 Replacement Due to Obsolescence

A copier was purchased 2 years ago for $1200 with an economic life of 5 years and a salvage value of $100. operating costs averaged $4200 annually and are expected to continue at the same level.
A new copier from the same company can be bought for $1500 with operating costs of $3500 per year, and the company is offering $500 as a trade-in for the old machine. The expected salvage value of the new copier is $400 after 5 years.
Another company leases copiers for $1000 per year. The company claims this will reduce operating costs to $2750. Since this company does not accept trade-ins, the machine currently in use would have to be sold on the open market for $300. If the MARR is 10% before taxes, should the defending copier be replaced by one of the challengers?

Solution:

Discount = $500 - 300 = $200, so the effective price of the new copier is $1500 - 200 = $1300. Using P=$300 for the defender,

$$\begin{aligned} EAC(D) &= (P-S)(A/P,10,3)+iS+4200 \\ &= (300-100)(0.40211)+(0.10)(100)+4200 \\ &= 90+4200=\$4290 \end{aligned}$$

$$\begin{aligned} EAC(NEW) &= (P-S)(A/P,10,5)+iS+3500 \\ &= [(1500-200)-400](0.2638)+(0.10)(400)+3500 \\ &= \$3777 \end{aligned}$$

$$EAC(LEASE) = 1000+2750=\$3750$$

Leasing is the best alternative; it also gives the company more flexibility.

Using P=\$500 (i.e. the trade-in):

$$EAC(D) = (500-100)(0.40211)+(0.10)(100)+4200=\$4371$$

$$EAC(NEW) = (1500-400)(0.2638)+0.10(400)+3500=\$3830$$

Now,

$$EAC(D)-EAC(NEW) = 4371-3830=\$541$$

Before,

$$EAC(D)-EAC(NEW) = 4290-3777=\$513$$

Difference = \$28. This is the result of the difference in capital recovery period of the defender and the challenger. using effective values is a more conservative approach.

6 Replacement Due to Inadequacy

An old bridge has a load limit of 4500 kg. A new bridge is needed with a capacity of 30000 kg. The developer has two options: reinforce the old bridge or build a new one.

The old bridge has no salvage value. Reinforcement would cost $30000 and would last for 10 years at which time the salvage value of the materials would be $8000.

A new bridge would cost $60000 and would last for 50 years with S = 0. It would cost $2000 to remove the old bridge, and maintenance costs are expected to be $2200 less annually than for the old bridge.

Annual property taxes will be 1% of first cost. If the MARR is 8%, which alternative should be selected?

Solution: R=Reinforced, N=New

$$\begin{aligned} EAC(R) &= (P-S)(A/P,8,10) + 0.08(S) + 2200 + 30000(0.01) \\ &= (30000-8000)(0.14903) + 0.08(30000) + 2200 + +300 \\ &= \$6419 \end{aligned}$$

$$\begin{aligned} EAC(N) &= P(A/P,8,50) + (0.01)60000 + 2000(A/P,8,50) \\ &= [60000+2000](0.08174) + 600 \\ &= \$5668 \end{aligned}$$

On the basis of EAC, the new bridge should be built. The advantage is $6419 - 5668 = $751 per year.