# Cha-4

## Cost Comparison of Alternative Methods

**Introduction:** Every need that arises in our industrial society can be satisfied in multiple ways.

- For example, there are alternative manufacturing processes for producing a commodity.
- Consequently, the engineering economist has the task of identifying the most desirable way of satisfying each need that arises.
- Generally, the disbursements associated with each alternative method span a period of several years, therefore it is necessary to weave the time value of money into any investigation.

- As the name implied the alternative methods for cost comparison differ solely with respect to cost but are alike with respect to income, serviceability, general convenience, etc.
- For example, in determining whether a commodity is to be produced manually or by automated equipment, we assume that the quality of the product is identical under the two methods.

## Description of Simplified Model

- Our immediate objective is to formulate standard techniques of cost comparison. Therefore a simplified model of the industrial world has the following characteristics:

1) All economical & technological conditions remain completely static, except where changes are expressly described. As a result, interest rates and costs remain constant as time elapsed, and each asset is replaced with an exact duplicate when it is retired.

2) The future can be foreseen with certainty. Consequently, all forecasts and projections prove to be accurate in every respect.

3) Interest is compounded annually

4) All disbursements and receipts associated with an asset occur at the beginning or end of a year.

❖ There are several techniques of cost comparison, and we shall study each method in turn.

# 1. PRESENT WORTH OF COSTS

- Where two alternative assets are to be compared with respect to cost we may establish a basis of comparison in this manner:

1. Select a period of time that encompasses an integral number of lives of each asset.
2. Select the beginning of this time period as the valuation date, and find the value at this date of the entire set of payments associated with each asset during this time period.

- This value is called the present worth of costs, and the period of time selected is known as the analysis period.
- The present worth of costs is abbreviated PW, with a subscript to identify the method.

# 1. PRESENT WORTH OF COSTS

**Example:** Two types of equipment are available for performing a manufacturing operation; the cost data associated with each type are recorded in the accompanying table. Applying an interest rate of 8%, determine which type is more economical using present-worth of cost?

| | Type A | Type B |
|---|---|---|
| First cost, $ | 88,000 | 45,000 |
| Salvage value, $ | 7,500 | 4,000 |
| Annual maintenance, $ | 4,300 | 5,200 |
| Life, years | 12 | 6 |

**Solution:**

- Computing the present worth of costs
- Select a 12year analysis period, this encompasses one life of type A and two lives of type B.
- The capital payments that occur during this period are recorded in figure below, where expenditures are shown below the baseline and income above it.

- With respect to type A, the salvage value pertaining to the first life fall within the analysis period.
- Similar comments apply with respect to type B.
- Payments for annual maintenance are treated as a lump-sum end of year expenditures.

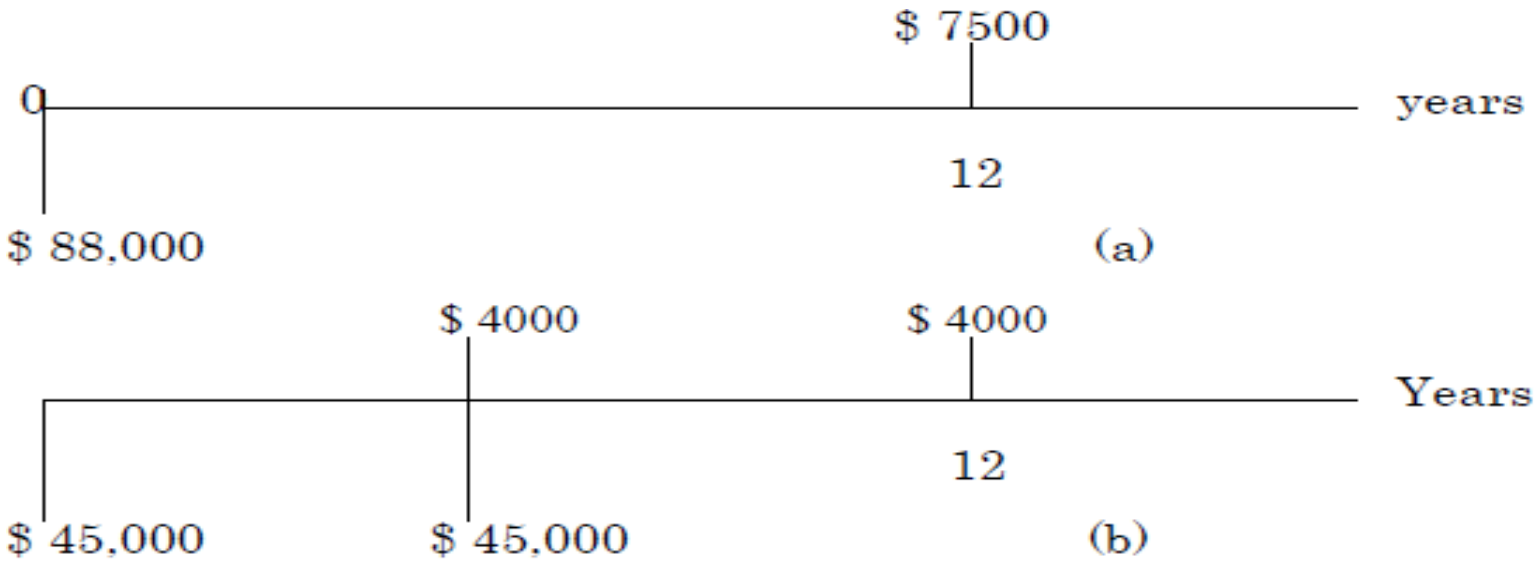



Fig Capital payments (a) Type A: (b) Type B.

- Present Worth of costs(PW) for each type is:- $PW_A$=88,000+4300(Pu/A,12)-7500(P/F,12)

  =88,000+4300[1-(1+0.08)$^{-12}$/0.08]-7500(1+0.08)$^{-12}$

  =88,000+4300*7.53608-7500*0.39711

**$PW_A$=$117,430**

Similarly $PW_B$:-

$PW_B$=45,000+ (45000-4000)(P/F,6)+5200(Pu/A,12)-4000(P/F,12)

=45,000+ 41000(1+0.08)$^{-6}$ +5000[1-(1+0.08)$^{-12}$/0.08]-4000(1+0.08)$^{-12}$

=45,000+41,000*0.63017+5200*7.53608-4000*0.39711

**$PW_B$=$108,440**

Comparing the cost for the two type $PW_B$ < $PW_A$

Therefore Type B equipment is more economical.

# 2. CAPITALIZED COST

- The analysis period may be made to encompass an infinite number of lives, and the cost calculations are thereby simplified.
- The present worth of costs for an infinite period is known as the capitalized cost (CC) of the asset.
- Mathematically, the capitalized cost of an asset may be interpreted as sum of money that must be deposited in a fund at the date of purchase at the stipulated interest rate to just provide all payments for perpetual service.
- The notational system is as follows:

Bo = first cost of asset L = salvage value

n = Service life of asset, years

C = annual operating cost, including maintenance & normal repairs.

- We define a standard asset as one having these characteristics: The only capital payments are Bo & L, and C remains constant during the life of the asset.
- The following equation for the capitalized cost of a standard asset:

$$CC = Bo + \frac{(Bo - L)\left(\frac{A}{Fu}, n\right)}{i} + \frac{C}{i}.$$

***OR***

$$CC = \frac{(Bo - L)\left(A/Pu, n, i\right)}{i} + L + \frac{C}{i}$$

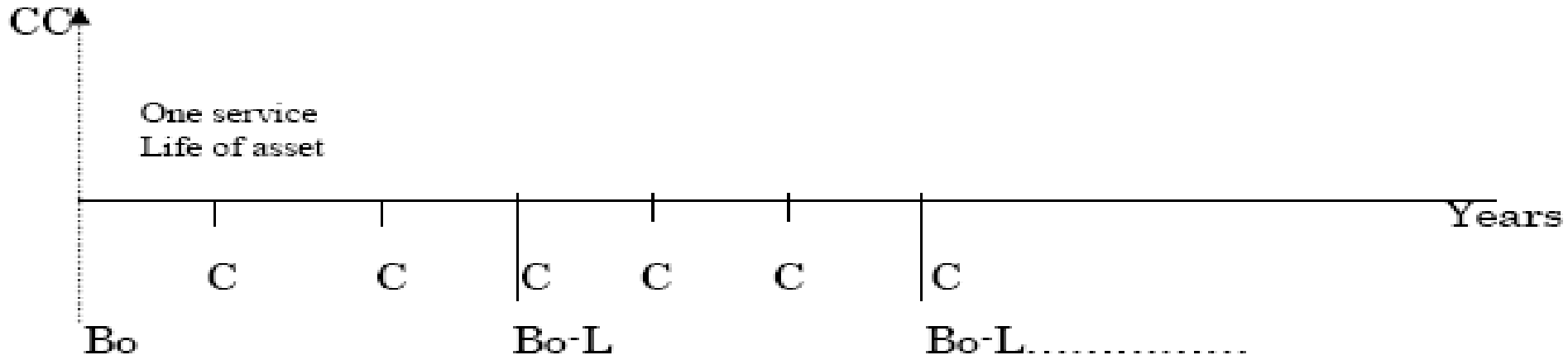
❖ In special where the life of the asset is infinite, we have:-

$$CC = Bo + \frac{C}{i}$$

i. Bo is a single present payment and so we take it as it is.

ii. Bo-L is the periodic payment made indefinitely.

iii. C is annual operating cost, including maintenance & normal repairs, which is made annually(lump-sum).



# With reference to an ordinary uniform series, let:

A= Periodic Payment

Pu= Present worth of series

Fu= Future worth of series

n= number of payments

i= interest rate

**Evaluating all payments at the origin date of the series and summing the results, we obtain:**

$$Pu = A\,(1+i)^{-1} + (1+i)^{-2} + \ldots\ldots\ldots + (1+i)^{-n}$$

Then $$Pu = \frac{A\ 1-(1-i)^{-n}}{i} = \frac{A\ 1-1/(1+i)^{n}}{i}$$

Similarly, $$Fu = \frac{A\,(1+i)^{n}-1}{i}$$

❖ In many instances, the present worth of a uniform series is known and it is necessary to calculate the periodic payments.

$$A = Pu\ \frac{i}{1-(1+i)^{-n}} = Pu\ \frac{i}{1-1/(1+i)^{n}}$$

$$\left(A/_{Pu,n,i}\right) = \frac{i}{1-(1+i)^{-n}}$$

❖ Similarly, the periodic payment with respect to future worth of a uniform series of payment is:

$$(A/Fu,n,i)=i/(1+i)^{n}-1$$

**Example:** Two alternative machines have the cost data shown in the accompanying table. Compare these machines on the basis of capitalized cost, applying an interest rate of 11.5 percent.

| | Machine A | Machine B |
|---|---|---|
| First cost, $ | 95,000 | 63,000 |
| Salvage value,$ | 6,000 | 5,000 |
| Annual maintenance, $ | 9,200 | 12,500 |
| Life, years | 8 | 5 |

**Solution:** capitalized cost for each machine is:-

$CC_A=(B_O-L)(A/Pu,8)/i+L+C/i$

$CC_A=(95{,}000-6{,}000)(A/Pu,8)/0.115+6000+9200/0.115$ Where: $(A/Pu,n)=i/1-(1+i)^{-n}=0.115/1-(1+0.115)^{-8}=0.19780$

Therefore: $CC_A=8900*019780+600+9200/0115=\$239{,}080$

Similarly for machine B:

$CC_B=(B_O-L)(A/Pu,5)/i+L+C/i$

$CC_B=(63{,}000-5{,}000)(0.27398)/0.115+5000+12500/0.115$ $CC_B=\$251{,}880$

**Therefore, Machine A is less costly.**