PART-II COST ANALYSIS

2.1 INTRODUCTION

Value analysis is one of the major techniques of cost reduction and cost prevention. It is a disciplined approach that ensures necessary functions for minimum cost without sacrificing quality, reliability, performance, and appearance. According to the Society of American Value Engineers (SAVE),

Value Analysis is the systematic application of recognized techniques which identify the function of a product or service, establish a monetary value for the function and provide the necessary function reliably at the lowest overall cost.

It is an organized approach to identify unnecessary costs associated with any product, material part, component, system or service by analysing the function and eliminating such costs without impairing the quality, functional reliability, or the capacity of the product to give service

2.1.1 WHEN TO APPLY VALUEANALYSIS

One can definitely expect very good results by initiating a VA programme if one or more of the following symptoms are present:

1. Company's products show decline in sales.
2. Company's prices are higher than those ofits competitors.
3. Rawmaterialscosthasgrowndisproportionatetothevolumeofproduction.
4. New designs are beingintroduced.
5. The cost of manufacture is rising disproportionate to the volume ofproduction.
6. Rateofreturnoninvestmenthasafallingtrend.
7. Inabilityofthefirmtomeetitsdeliverycommitments.

2.1.2Value

The term 'value' is used in different ways and, consequently, has different meanings. The designer equates the value with reliability; a purchase person with price paid for the item; a production person with what it costs to manufacture, and a sales person with what the customer is willing to pay.

Example

Cost value. It is the summation of the labour, material, overhead and all other elements of cost required to produce an item or provide a service compared to a base.

Exchange value. It is the measure of all the properties, qualities and features of the product, which make the product possible of being traded for another product or formoney.

Value analysis/value engineering

It is a special type of cost reduction technique. It critically investigates and analyses the different aspects of materials, design, cost and production of each and every component of the product in produce it economically without decreasing its utility, function or reliability.

Applications

The various application areas of value engineering are machine tool industries, industries making accessories for machine tools, auto industries, import substitutes,etc.

2.2 INTRODUCTION

In the process of carrying out business activities of an organization, a component/product can be made within the organization or bought from a subcontractor. Each decision involves its own costs.

So, in a given situation, the organization should evaluate each of the above make or buy alternatives and then select the alternative which results in the lowest cost. This is an important decision since it affects the productivity of the organization

In the long run, the make or buy decision is not static. The make option of a component/product may be economical today; but after some time, it may turn out to be uneconomical to make the same.

Thus, the make or buy decision should be reviewed periodically, say, every 1 to 3 years. This is mainly to cope with the changes in the level of competition and various other environmental factors.

Make or Buy Decisions - is a determination whether to produce a component part internally or to buy it from an outside supplier. The Organization should evaluate the costs and benefits of manufacturing a product or product component against purchasing it and then select the alternative which results in the lower cost.

2.2.1 CRITERIA FOR MAKE ORBUY

In this section the criteria for make or buy arediscussed.

1. Criteria formake

The following are the criteria for make:

1. The finished product can be made cheaper by the firm than by outsidesuppliers.
2. The finished product is being manufactured only by a limited number of outside firms which are unable to meet the demand.
3. The part has an importance for the firm and requires extremely close qualitycontrol.
4. The part can be manufactured with the firm's existing facilities and similar to other items in which the company has manufacturingexperience.

2. Criteria forbuy

The following are the criteria for buy:

1. Requires high investments on facilities which are already available at suppliers plant.
2. The company does not have facilities to make it and there are more profitable opportunities for investing company's capital.
3. Existing facilities of the company can be used more economically to make otherparts.
4. The skill of personnel employed by the company is not readily adaptable to make thepart.
5. Patent or other legal barriers prevent the company for making thepart.
6. Demandforthepartiseithertemporaryorseasonal.

2.3 APPROACHES FOR MAKE OR BUYDECISION

Types of analysis followed in make or buy decision are as follows:

1. Simple costanalysis
2. Economicanalysis
3. Break-evenanalysis

1. Simple CostAnalysis

The concept is illustrated using an example problem.

EXAMPLE

A company has extra capacity that can be used to produce a sophisticated fixture which it has been buying for Rs. 900 each. If the company makes the fixtures, it will incur materials cost of Rs. 300 per unit, labour costs of Rs. 250 per unit, and variable overhead costs of Rs. 100 per unit. The annual fixed cost associated with the unused capacity is Rs. 10,00,000. Demand over the next year is estimated at 5,000 units. Would it be profitable for the company to make the fixtures?

Solution

We assume that the unused capacity has alternative use.

Cost to make

Variable cost/unit = Material + labour + overheads

= Rs. 300 + Rs. 250 + Rs. 100

= Rs. 650

Total variable cost = (5,000 units) (Rs. 650/unit)

= Rs. 32,50,000

Add fixed cost associated with unused capacity + Rs.10,00,000

Totalcost = Rs.42,50,000

Cost to buy

Purchase cost

= (5,000 units) (Rs. 900/unit)

= Rs. 45,00,000

Add fixed cost associated with unused capacity + Rs.10,00,000

Totalcost = Rs.55,00,000

. EconomicAnalysis

The following inventory models are considered to illustrate this concept:

Purchase model

Manufacturing model

The formulae for EOQ and total cost (TC) for each model are given in the following table:

Purchasemodel	*Manufacturingmodel*
$Q1 = \sqrt{\frac{2C_oD}{C_c}}$	$Q2 = \sqrt{\frac{2CD}{C_c(1 - r/k)}}$

$$TC = D\,P + \frac{DC_o}{Q1} + \frac{Q1 \times C_c}{2} \qquad TC = D\,P + \frac{DC_o}{Q2} + C_c(k - r)\frac{Q2}{2\,.k}$$

where
D = demand/year

P = purchase price/unit

C_C= carrying cost/unit/year

C_O = ordering cost/order or set-up cost/set-up

k = production rate (No. of units/year)

r = demand/year

$Q1$ = economic order size

EXAMPLE

An item has a yearly demand of 2,000 units. The different costs in respect of make and buy are as follows. Determine the best option.

	Buy	*Make*
Itemcost/unit	Rs. 8.00	Rs.5.00
Procurementcost/order	Rs.120.00	
Set-upcost/set-up		Rs.60.00
Annual carrying cost/ item/year	Rs. 1.60	Rs. 1.00
Productionrate/year		8,000units

Solution

Buy option

D = 2,000 units/year
C_o= Rs. 120/order
C_c= Rs. 1.60/unit/year

$$Q1 = \sqrt{\frac{2C_oD}{C_c}} = \sqrt{\frac{2 \times 2,000 \times 120}{1.60}}$$

= 548 units (approx.)

$$TC = DP + \frac{DC_o}{Q1} + \frac{Q1C_c}{2}$$

$$= 2,000 \quad 8 + \frac{2,000 \times 120}{548} + \frac{548 \times 1.60}{2}$$

= Rs. 16,876.36

Make option

C_o= Rs. 60/set-up
r = 2,000 units/year
C_c= Re 1/unit/year
k = 8,000 units/year

$$Q2 = \sqrt{\frac{2C_or}{C_c[1-(r/k)]}}$$

$$= \sqrt{\frac{2 \times 60 \times 2,000}{1.0\,(1-2,000/8,000)}} = 566 \text{ units(approx.)}$$

$$TC = DP + \frac{D \times C_o}{Q2} + C_c \frac{Q2(k - r)}{2 \times k}$$

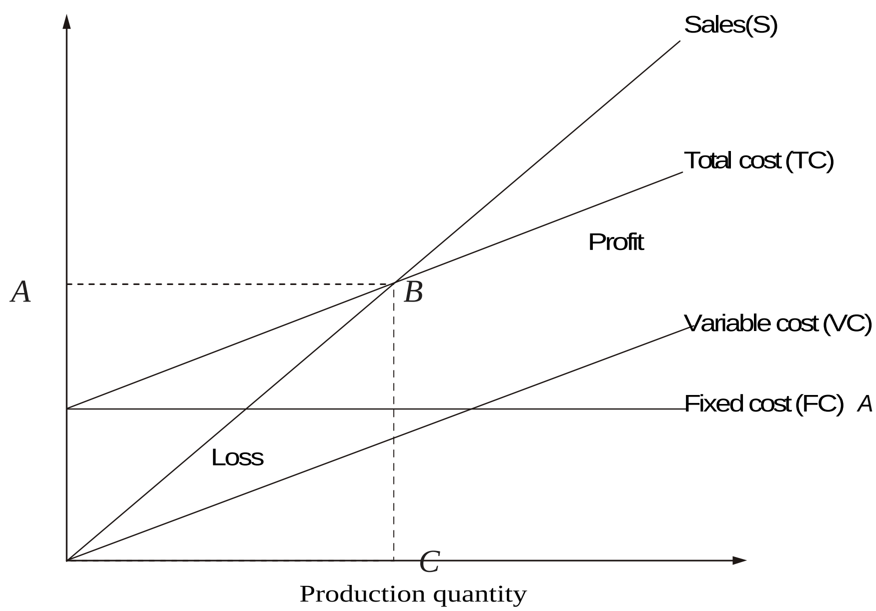
$$= 2{,}000 \quad 5.00 + \frac{2{,}000 \times 60}{566} + 1.0\,(8{,}000 - 2{,}000)\,\frac{566}{2 \times 8{,}000}$$

$$= \text{Rs.}10{,}424.26$$

Result: The cost of making is less than the cost of buying.
Therefore, the firm should go in for the making option.

3. Break-evenAnalysis

The break-even analysis chart is shown in Fig.



TC = total cost
FC = fixedcost

TC = *FC* + variable cost

B = the intersection of *TC* and sales (no loss or no gain situation)

A = break-even sales

C = break-even quantity/break-even point (BEP)

The formula for the break-even point (BEP) is

$$\text{BEP} = \frac{FC}{\text{Selling price/ unit} - \text{Variable cost / unit}}$$

EXAMPLE

There are three alternatives available to meet the demand of a particular product. They areas follows:

(a) Manufacturing the product by using process A (b) Manufacturing the product by using process B (c) Buying theproduct

The details are as given in the following table:

Costelements	*Manufacturing theproductby processA*	*Manufacturing the productby processB*	*Buy*
Fixed cost/year (Rs.) Variable/unit (Rs.)	5,00,000	6,00,000	
Purchase price/unit (Rs.)	175	150	
			125

The annual demand of the product is 8,000 units. Should the company make the product using process A or process B or buy it?

Solution

Annual cost of process A = FC+VC Volume
= 5,00,000+175 8,000
= Rs. 19,00,000

Annual cost of process B = FC +VC Volume
= 6,00,000+150 8,000
= Rs. 18,00,000

Annual cost of bu = Purchaseprice/unit Volume
= 125 8,000
= Rs. 10,00,000

Since the annual cost of buy option is the minimum among all the alternatives, the company should buy theproduct

. .

2.4 Function

Function is the purpose for which the product is made. Identification of the basic functions and determination of the cost currently being spent on them are the two major considerations of valueanalysis.

Function identifies the characteristics which make the product/component/ part/item/device to work or sell. "Work functions" lend performance value while "sell functions" provide esteemvalue.

Verbs like "support", "hold", "transmit", "prevent", "protect", "exhibits", "control", etc., are used to describe work functions, while "attract", enhance", "improve", "create", etc., are used to describe "sell" functions. For example, in a "bus driver cabin", the functional analysisofsomeofthepartsaregiveninTable

Functional Analysis of Some Parts of a Bus Driver Cabin

Component of study	*Functional analysis*	
	Verb	Non Steering
wheel	Control	Direction of gear box
Change	Speed Brake system Clear	Stop
Vehicle Wiper Horn	Make	Water
Side mirror	Show	Sound
		Side Traffic.

2.4.1 Classificationofthefunctions

Rarely do all functions assume equal importance. Usually, some functions are more important than others. Functions can be classified intothefollowingthreecategories:

1. Primaryfunction
2. Secondaryfunction
3. Tertiaryfunction

1. Primaryfunctionsarethebasicfunctionsforwhichtheproductisspeciallydesignedtoachieve.Primary functions, therefore, are the most essential functions whose non-performance would make the product worthless,e.g.aphotoframeexhibitsphotographs,achairsupportsweight,afluore.nttubegiveslight.

2. Secondary functions are those which, if not in-built, would not prevent the device from performing its primaryfunctions,e.g.,armsofachairprovidesupportforhands.Secondaryfunctionsareusuallyrelatedto convenience.Theproductcanstillworkandfulfillitsintendedobjectiveevenifthesefunctionsarenotin-builtandyettheymaybenecessarytoselltheproduct.

3. Tertiary functions are usually related to esteem appearance. For example, Sunmicatop of a table gives esteemappearanceforthetable.

Examples

- ✓ Letusconsiderasingleexampleofpaintingacompanybustoexplainalltheabovethreefunctions.Here,the primaryfunctionofpaintingistoavoidcorrosion.
- ✓ Thesecondaryfunctionistoidentifythecompanytowhichthebusbelongsbythecolourofthepaint(e.g.blue colourforAshokLeylandLtd.).
- ✓ Thetertiaryfunctionistoimpartaverygoodappearancetothebusbyusingbrilliantcolours.

2.5 Aims Theaimsofvalueengineeringareasfollows:

- ✓ Simplify theproduct.
- ✓ Use (new) cheaper and bettermaterials.
- ✓ Modify and improve productdesign.
- ✓ Use efficientprocesses.
- ✓ Reduce the productcost.
- ✓ Increasetheutilityoftheproductbyeconomicalmeans.
- ✓ Save money or increase theprofits.

2.6 Value EngineeringProcedure

The basic steps of value engineering are as follows:

(a) Blast (i) Identify theproduct.
(ii) Collect relevantinformation.
(iii) Define differentfunctions.
(b) Create (iv) Different alternatives.
(v) Critically evaluate the alternatives.
(c) Refine (vi) Develop the bestalternative.
(vii) Implement the alternative.

Step1:Identifytheproduct.First,identifythecomponentforstudy.Infuture,anydesignchangeshouldadd valueanditshouldnotmaketheproductasobsoleteone.Valueengineeringcanbeappliedtoaproductasawholeorto sub-units.

Step 2: Collect relevant information. Information relevant to the followingmustbe collected:

- ✓ Technicalspecificationswithdrawings
- ✓ Productionprocesses,machinelayoutandinstructionsheet
- ✓ Timestudydetailsandmanufacturingcapacity
- ✓ Completecostdataandmarketingdetails
- ✓ Latestdevelopmentinrelatedproducts

Step 3: Define different functions. Identify and define the primary, secondary and tertiary functions of the product or partsofinterest. Also,specifythevalue content of each function and identifythehigh cost areas.

Step 4: Different alternatives.Knowing the functions of each component part and its manufacturing details, generatetheideasandcreatedifferentalternativessoastoincreasethevalueoftheproduct.Valueengineeringshouldbe doneafterabrainstormingsession.Allfeasibleornon-feasiblesuggestionsarerecordedwithoutanycriticism;rather, personsareencouragedtoexpresstheirviewsfreely.

2.7 Interest Formulas Interest rate can be classified into simple interest rate and compound interestrate.

- ✓ In simple interest, the interest is calculated, based on the initial deposit for every interest period. In this case, calculation of interest on interest is notapplicable.
- ✓ In compound interest, the interest for the current period is computed based on the amount (principal plus interest up to the end of the previous period) at the beginning of the currentperiod.

The notations which are used in various interest formulae are as follows:

P = principal amount

n = No. of interestperiods

i= interest rate (It may be compounded monthly, quarterly, semiannually or annually)

F =future amount at the end of year *n*

A = equal amount deposited at the end of every interest period

G = uniform amount which will be added/subtracted period after period to/from the amount of deposit A1 at the end of period 1

2.8 Time Value of Money - .It represents the growth of capital per unit period. The period maybeamonth,aquarter,semiannualorayear.

An interest rate 15% compounded annually means that for every hundred rupees invested now, an amount of Rs. 15 will be added to the account at the end of the first year. So, the total amount at the end of the first year will be Rs. 115.

At the end of the second year, again 15% of Rs. 115, i.e. Rs. 17.25 will be added to the account.

Hence the total amount at the end of the second year will be Rs. 132.25. The process will continue thus till the specified number of years.

I f an investor invests a sum of Rs. 100 in a fixed deposit for five years with an interest rate of 15% compounded annually, the accumulated amount at the end of every year will be as shown in Table

Compound Amounts

(amount of deposit = Rs. 100.00)

Year end	*Interest* (Rs.)	*Compound amount* (Rs.)
0		100.00
1	15.00	115.00
2	17.25	132.25
3	19.84	152.09
4	22.81	174.90
5	26.24	201.14

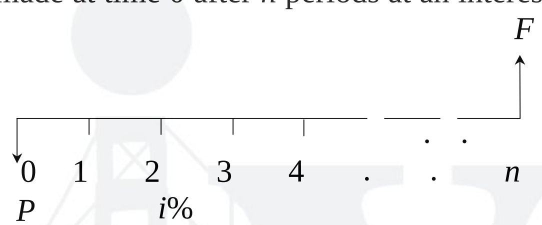
The formula to find the future worth in the third column is

$$F = P(1+i)^n$$

where
P = principal amount invested at time 0,
F = future amount,
i= interest rate compounded annually,
n = period ofdeposit.

The maturity value at the end of the fifth year is Rs. 201.14. This means that the amount Rs. 201.14 at the end of the fifth year is equivalent to Rs. 100.00 at time 0 (i.e. at present). This is diagrammatically shown in Fig. 3.1. This explanation assumes that the inflation is at zeropercentage.

2.9 Single-Payment Compound Amount - Here, the objective is to find the single future sum (F) of the initial payment (P) made at time 0 after n periods at an interest rate $i$compounded every period.



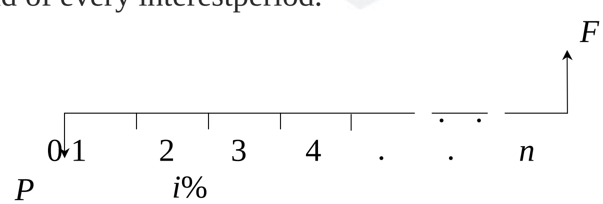
Cash flow diagram of single-payment compound amount.

The formula to obtain the single-payment compound amount is

$$F = P(1 + i)^n = P(F/P, i, n)$$

where
(F/P, i, n) is called as single-payment compound amount factor.

2.10 Single-Payment Present Worth Amount - Here, the objective is to find the present worth amount (P) of a single future sum (F) which will be received after n periods at an interest rate of $i$compounded at the end of every interestperiod.



Cash flow diagram of single-payment present worth amount.

The formula to obtain the present worth is

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

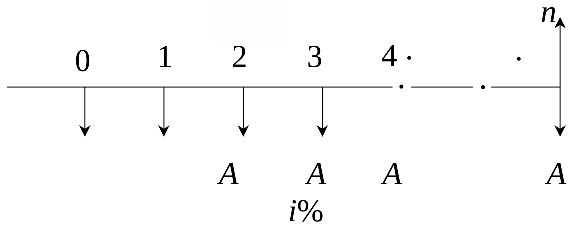
.

Where

(P/F, i, n) is termed as *single-payment present worth factor*.

2.11 Equal-Payment Series Sinking Fund

In this type of investment mode, the objective is to find the equivalent amount (A) that should be deposited at the end of every interest period for n interest periods to realize a future sum (F) at the end of the nth interest period at an interest rate of$i$.



A = equal amount to be deposited at the end of each interest period
n = No. of interest periods
i= rate of interest
F = single future amount at the end of the nth period

The formula to get $F$is

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

Where

(A/F, i, n) is called as *equal-payment series sinking fund factor*.

2.12 Equal-Payment Series Present Worth Amount The objective of this mode of investment is to find the present worth of an equal payment made at the end of every interest period for n interest periods at an interest rate of icompounded at the end of everyinterest period.

The corresponding cash flow diagram is shown in Fig. 3.8. Here,

P = present worth
A = annual equivalent payment
i= interest rate
n = No. of interest periods

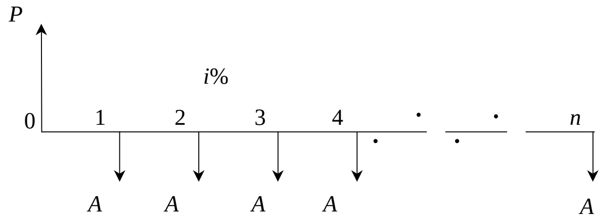
The formula to compute P is

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

Where

(P/A, i, n) is called equal-payment series present worth factor

2.13 Equal-Payment Series capital recovery The objective of this mode of investment is to find the annual equivalent amount (A) which is to be recovered at the end of every interest period for n interest periods for a loan (P) which is sanctioned now at an interest rate of i compounded at the end of every interestperiod



Cash flow diagram of equal-payment series capital recovery amount.

P = present worth (loanamount)
A = annual equivalent payment (recovery amount)
i= interest rate
n = No. of interest periods

The formula to compute P is as follows:

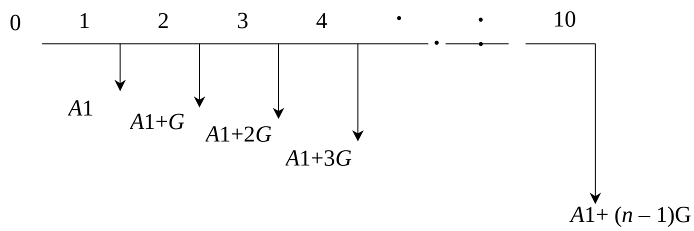
$$A=P \frac{i(1+i)^n}{(1+i)^n-1} = P(A/P, i, n)$$

Where,

$(A/P, i, n)$ is called *equal-payment series capital recovery factor*.

2.14 Uniform Gradient series annual equivalent The objective of this mode of investment is to find the annual equivalent amount of a series with an amount $A1$ at the end of the first year and with an equal increment (G) at the end of each of the following n – 1 years with an interest rate $i$compoundedannually.

The corresponding cash flow diagram is shown in Fig



Cash flow diagram of uniform gradient series annual equivalent amount.

The formula to compute A under this situation is

$$A = A1+G \frac{(1+i)^n - in - 1}{i(1+i)^n - i}$$

$$= A1 + G\ (A/G, i, n)$$

here
Where
$(A/G, i, n)$ is called *uniform gradient series factor.*

2.15 Effective Interest rate Let $i$be the nominal interest rate compounded annually. But, in practice, the compounding may occur less than a year. For example, compounding may be monthly, quarterly, or semi-annually. Compounding monthly means that the interest is computed at the end of every month. There are 12 interest periods in a year if the interest is compounded monthly. Under such situations, the formula to compute the effective interest rate, which is compounded annually, is Effective interest rate, $R = 1 + i/C^{C} - 1$

where,
i= the nominal interest rate
C = the number of interest periods in a year.