DKB22 - FUNCTIONAL MANAGEMENT

Unit - I

Financial Management - Objectives – functions – Role of financial Management Risk – Return Relationship – Time value of Money – Sources of Capital – Cost of Capital Cost of debt, Cost of Preference shares, Cost of equity, weighted average cost of capital Average and Marginal cost of capital.

Unit - II

Capital Budgeting, Capital budgeting under the conditions of Capital rationing and inflationary conditions. Working Capital Decisions – Working capital policy – management of cash and near – cash assets. Management of Receivables. Management of inventory.

Unit - III

Financial analysis and planning: Financial Statements, Financial Ration Analysis, Operating and Financial leverage. Break even Analysis.

Unit - IV

Production and operations management – Definition – Scope – Importance. Plant Location – Selection techniques for new and expansion. Layout – Types – Advantages – Applicability. Capacity Planning. Models – Process Planning – Economic Batch Quantity – Joint Cycle – Multiple Products.

Unit - V

Production Planning and Control – Master Production Schedule – Sequencing – Scheduling – Statistical Techniques in controlling – Maintenance Management. Quality Management. Work Study. Procedures – Applicability. Industrial Safety.

LESSON - 1
FINANCIAL MANAGEMENT

CONTENTS

1.0. Financial management:

Introduction: Financial Management means the efficient and effective management of money (funds) in such a manner as to accomplish the objectives of the organization. Financial management can be defined as the management of the finances of an organization in order to achieve the financial objectives of the organization.

Business concern needs finance to meet their requirements in the economic world. Any kind of business activity depends on the finance. Hence, it is called as lifeblood of business organization. Whether the business concerns are big or small, they need finance to fulfill their business activities.

In the modern world, all the activities are concerned with the economic activities and very particular to earning profit through any venture or activities. The entire business activities are directly related with making profit. (According to the economics concept of factors of production, rent given to landlord, wage given to labour, interest given to capital and profit given to shareholders or proprietors), a business concern needs finance to meet all the requirements. Hence finance may be called as capital, investment, fund etc., but each term is having different meanings and unique characters. Increasing the profit is the main aim of any kind of economic activity.

1.1 MEANING OF FINANCE

Finance may be defined as the art and science of managing money. It includes financial service and financial instruments. Finance also is referred as the provision of money at the time when I is needed. Finance function is the procurement of funds and their effective utilization in business concerns.

The concept of finance includes capital, funds, money, and amount. But each word is having unique meaning. Studying and understanding the concept of finance become an important part of the business concern.

1.2 DEFINITION OF FINANCIAL MANAGEMENT:

Financial management is the management of monetary resources. It involves planning accurately, directing the monetary resources at correct time and controlling the financial activities of a firm. Financial management is very important for a business to ensure it can run smoothly. Finance is an aspect which, if neglected, can lead to severe losses and closure of a firm.

1.3 The Functions of Financial Management are as follows:

- Estimation of capital requirement: The main function of a finance manager is to estimate the costs of the firm. They must be capable to estimate the expected profits and future requirements of finance with regards to new policies, etc. This leads to an increase in the earning capacity of the firm.
- Determination of capital composition: The finance manager has to determine the ratio of capital involved in various projects. For example, the amount to be invested in short term projects and long term projects, what is the amount required to be kept for sundry expenses, staff salary, etc. If the money is short they must find outways to increase the equity from outside resources.
- Investment decision: The finance manager is a key decision makerin terms of investment making. They should always be aware of all the monetary resources available with the business which can help increase the company's profit margins by investing it.
- Profit management: In case of surplus profit, the finance manager can declare either dividends or issue bonus shares

1.4 RISK AND RETURN RELATIONSHIP

Capital budgeting requires the projection of cash inflow and outflow of the future. The future in always uncertain, estimate of demand, production, selling price, cost etc., cannot be exact. For example: The product at any time it become obsolete therefore, the future in unexpected. The following methods for considering the accounting of risk in capital budgeting. Various evaluation methods are used for risk and uncertainty in capital budgeting is as follows:

(i) Risk-adjusted cut off rate (or method of varying discount rate)
(ii) Certainly equivalent method.
(iii) Sensitivity technique.
(iv) Probability technique
(v) Standard deviation method.
(vi) Co-efficient of variation method.
(vii) Decision tree analysis.

(i) Risk-adjusted cutoff rate (or Method of varying): This is one of the simplest methods while calculating the risk in capital budgeting increase cut of rate or discount factor by certain percentage an account of risk.

(ii) Certainly equivalent method: It is also another simplest method for calculating risk in capital budgeting in for educed expected cash inflows by certain amounts it can be employed by multiplying the expected cash inflows by certainly equivalent co-efficient in order the uncertain cash inflow to certain cash inflows.

(iii) Sensitivity technique: When cash inflows are sensitive under different circumstances more than one forecast of the future cash inflows may be made. These inflows may be regarded on 'Optimistic', 'most likely' and 'pessimistic'. Further cash inflows may be discounted to find out the net present values under these three different situations. If the net present values under the three situations differ widely it implies that there is a great risk in the project and the investor's is decision to accept or reject a project will depend upon his risk bearing activities.

(iv) Probability technique: Probability technique refers to the each event of future happenings are assigned with relative frequency probability. Probability means the

likelihood of future event. The cash inflows of the future years further discounted with the probability. The higher present value may be accepted.

(v) Standard deviation method: Two Projects have the same cash outflow and their net values are also the same, standard durations of the expected cash inflows of the two Projects may be calculated to measure the comparative and risk of the Projects. The project having

(vi) Coefficient of variation method: Coefficient of variation is a relative measure of dispersion. It the projects here the same cost but different net present values, relatives measure, i.e., Co-efficient of variation should be risk induced. It can be calculated assigner standard deviation in said to be more risky as compared to the other.

(vii) Decision tree analysis: In the modern business world, putting the investments are become more complex and taking decisions in the risky situations. So, the decision tree analysis helpful for taking risky and complex decisions, because it considers all the possible events and each possible events are assigned with the probability.

1.5 OBJECTIVES OF FINANCIAL MANAGEMENT

Effective procurement and efficient use of finance lead to proper utilization of the finance by the business concern. It is the essential part of the financial manager. Hence, the financial manager must determine the basic objectives of the financial management. Objectives of Financial Management may be broadly divided into two parts such as:

1. Profit maximization
2. Wealth maximization.

Profit Maximization: Main aim of any kind of economic activity is earning profit. A business concern is also functioning mainly for the purpose of earning profit. Profit is the measuring techniques to understand the business efficiency of the concern. Profit maximization is also the traditional and narrow approach, which aims at, maximizes the profit of the concern.

Profit Maximization consists of the following important features.

1. Profit maximization is also called as cashing per share maximization. It leads to maximize the business operation for profit maximization.
2. Ultimate aim of the business concern is earning profit, hence, it considers all the possible ways to increase the profitability of the concern.
3. Profit is the parameter of measuring the efficiency of the business concern.
4. So it shows the entire position of the business concern.
5. Profit maximization objectives help to reduce the risk of the business.

Favorable Arguments for Profit Maximization

The following important points are in support of the profit maximization objectives of the business concern:

(i) Main aim is earning profit.
(ii) Profit is the parameter of the business operation.
(iii) Profit reduces risk of the business concern.
(iv) Profit is the main source of finance.
(v) Profitability meets the social needs also.

Unfavorable Arguments for Profit Maximization

The following important points are against the objectives of profit maximization:

(i) Profit maximization leads to exploiting workers and consumers.
(ii) Profit maximization creates immoral practices such as corrupt practice, unfair trade practice, etc.
(iii) Profit maximization objectives leads to inequalities among the share holders such as customers, suppliers, public shareholders, etc.

Drawbacks of Profit Maximization

Profit maximization objective consists of certain drawback also:

(i) **It is vague:** In this objective, profit is not defined precisely or correctly. It creates some unnecessary opinion regarding earning habits of the business concern.
(ii) **It ignores the time value of money:** Profit maximization does not consider the time value of money or the net present value of the cash inflow. It leads certain differences between the actual cash inflow and net present cash flow during a particular period.

(iii) **It ignores risk:** Profit maximization does not consider risk of the business concern. Risks may be internal or external which will affect the overall operation of the business concern.

Wealth Maximization: Wealth maximization is one of the modern approaches, which involves latest innovations and improvements in the field of the business concern. The term wealth means shareholder wealth or the wealth of the persons those who are involved in the business concern.

Wealth maximization is also known as value maximization or net present worth maximization. This objective is a universally accepted concept in the field of business.

Favorable Arguments for Wealth Maximization

(i) Wealth maximization is superior to the profit maximization because the main aim of the business concern under this concept is to improve the value or wealth of the shareholders.

(ii) Wealth maximization considers the comparison of the value to cost associated with the business concern. Total value detected from the total cost incurred for the business operation. It provides extract value of the business sconce

(iii) Wealth maximization considers both time and risk of the business concern.

(iv) Wealth maximization provides efficient allocation of resource

(v) It ensures the economic interest of the society.

Unfavorable Arguments for Wealth Maximization

(i) Wealth maximization leads to prescriptive idea of the business concern but it may not be suitable to present day business activities

(ii) Wealth maximization is nothing, it is also profit maximization, it is the indirect name of the profit maximization

(iii) Wealth maximization creates ownership-management contrivers

(iv) Management alone enjoys certain benefits.

(v) The ultimate aim of the wealth maximization objectives is to maximize the profit.

(vi) Wealth maximization can be activated only with the help of the profitable position of the business concern.

1.6 Role of finance manager: A description of the relationship between management and shareholders expressing the idea that managers act as agent for the shareholders, using delegated power to run the company in the shareholders best interest

- providing and interpreting financial information;
- monitoring and interpreting cash flows and predicting future trends;
- analyzing change and advising accordingly;
- formulating strategic and long-term business plans;
- researching and reporting on factors influencing business performance;
- analyzing competitors and market trends;
- developing financial management mechanisms that minimize financial risk;
- conducting reviews and evaluations for cost-reduction opportunities;
- Managing a company's financial accounting, monitoring and reporting systems;
- liaising with auditors to ensure annual monitoring is carried out;
- Developing external relationships with appropriate contacts, e.g. auditors, solicitors, bankers and statutory organizations such as the Inland Revenue;
- producing accurate financial reports to specific deadlines;
- managing budgets;
- arranging new sources of finance for a company's debt facilities;
- supervising staff;
- Keeping abreast of changes in financial regulations and legislation.

QUESTIONS FOR DISCUSSION

1. Define financial management
2. Explain the functions of financial management
3. Discuss the Risk Return Relationship

LESSON – 2

CONTENTS

2.0 THE TIME VALUE OF MONEY

Introduction

Now, we are going to learn one of the most important topics in finance, that is, the time value of money. Note that almost every course, which you will take as finance major, depends largely on the time value of money. Hence, it is a good idea to spend a fair amount of time in learning the concepts.

2.1 Essentially, we will learn the following concepts:

1. The conventions used in the study of time value of money
2. The time value of money under simple rate of interest

The simple rate of interest nowadays is mostly of academic interest. You will seldom find any transaction either in the real world or in the academics that is based on the simple rate of interest. In fact, this is a fortunate development in the sense that the only thing that is simple about the simple rate of interest is its name. Otherwise the mathematical foundations and the

resultant applications are almost impossible to deal with mathematically. Just to understand its complexity we will devote some time on this topic.

In the simple rate of interest we will learn

a. Future value of an amount

b. Present value of an amount

c. Future value of an annuity

d. Present value of an annuity

3. **Compound rate of interest**: All the topics in the time value of money that we will learn are under compound rate of interest. The topic that will be covered can be broadly categorized as in two main categories

a. The time value concepts under the lump sum case

b. The time value concepts under a series of payments case

In lump sum case we will learn

a. Present value of an amount

b. Future value of an amount

c. Finding the unknown rate of interest

d. Finding the unknown time period

Under the series of payments topic we will learn present and future value of a series of payments including future and present value of annuities and annuity dues. We will also learn how to find the unknown rate of interest as well as the unknown time period. All of the above concepts will be dealt with under annual compounding, compounding '*m*' (*m*>1) times per year and continuous compounding.

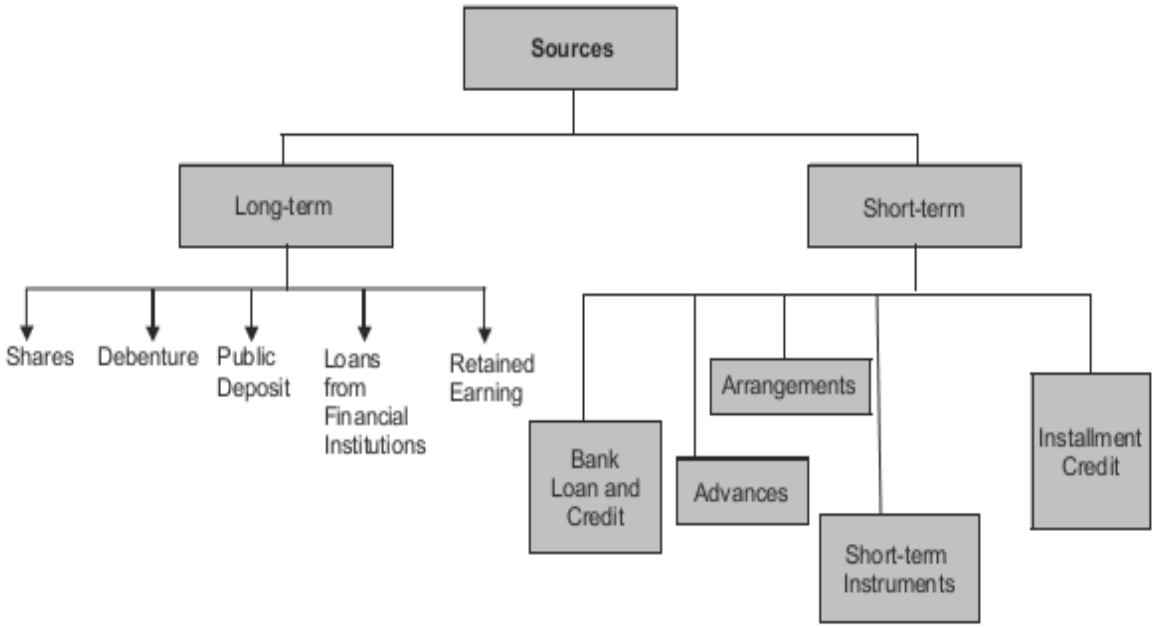
4. **Special topics** : Under this we will discuss the concept of time value of money for such topics but not limited to cash flows growing at a constant rate (under the constant growth rate) and/or under constant level increments, when compounding and deposit intervals are different etc

2.2 SOURCES OF WORKING CAPITAL

Working Capital requirement can be normalized from short-term and long-term sources.

Each source will have both merits and limitations up to certain extract. Uses of Working

Capital may be differing from stage to stage.



The above sources are also classified into internal sources and external sources of working capital.

Internal sources such as:

- Retained Earnings
- Reserve and Surplus
- Depreciation Funds etc.

External sources such as:

- Debentures and Public Deposits
- Loans from Banks and Financial Institutions
- Advances and Credit
- Financial arrangements like Factoring, etc.

Determining the Finance Mix

Determining the finance mix is an important part of working capital management. Under this decision, the relationship among risk, return and liquidity are measured and also which type of financing is suitable to meet the Working Capital requirements of the business concern.

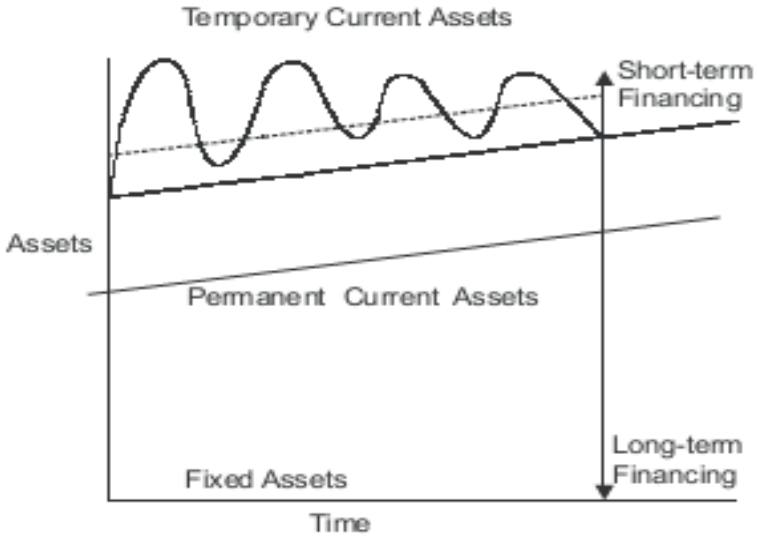
There are three basic approaches for determining an appropriate Working Capital finance mix.

1. Hedging or matching approach
2. Conservative approach
3. Aggressive approach.

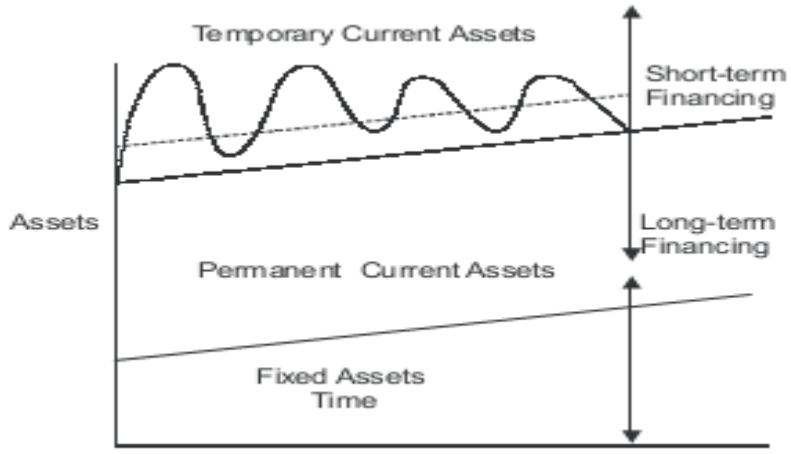
1. **Hedging Approach**: Hedging approach is also known as matching approach. Under this approach, the business concern can adopt a financial plan which matches the expected life of assets with the expected life of the sources of funds raised to finance assets.

   When the business follows matching approach, long-term finance shall be used to fixed assets and permanent current assets and short-term financing to finance temporary or variable assets.

2. **Conservative Approach**: Under this approach, the entire estimated finance in current assets should be financed from long-term sources and the short-term sources should be used only for emergency requirements. This approach is called as "Low Profit – Low Risk" concept.



3. **Aggressive Approach**: Under this approach, the entire estimated requirement of current assets should be financed from short-term sources and even a part of fixed assets financing be financed from short- term sources. This approach makes the finance mix more risky, less costly and more profitable.



2.3 COST OF DEBT:

Cost of debt is the after tax cost of long-term funds through borrowing. Debt may be issued at par, at premium or at discount and also it may be perpetual or redeemable.

Debt Issued at Par: Debt issued at par means, debt is issued at the face value of the debt. It may be calculated with the help of the following formula.

$$\mathbf{Kd = (1 – t) R}$$

Where,

Kd = Cost of debt capital

t = Tax rate

R = Debenture interest rate

Debt Issued at Premium or Discount: If the debt is issued at premium or discount, the cost of debt is calculated with the help of the following formula.

$$\mathbf{Kd = pIN (1 – t)}$$

Where,

Kd = Cost of debt capital

I = Annual interest payable

Np = Net proceeds of debenture

t = Tax rate

Cost of Perpetual Debt and Redeemable Debt: It is the rate of return which the lenders expect. The debt carries a certain rate of interest.

Kdb =ppI 1/n(P N)n\1/ n(P N)/ 2+

Where,

I = Annual interest payable

P = Par value of debt

Np = Net proceeds of the debenture

n = Number of years to maturity

Kdb = Cost of debt before t

Cost of debt after tax can be calculated with the help of the following formula:

K da=K db×(1–t)

Where,

Kda = Cost of debt after tax

Kdb = Cost of debt before tax

t = Tax rate

2.4 Cost of Preference Share Capital: Cost of preference share capital is the annual preference share dividend by the net proceeds from the sale of preference share.

Cost of Retained Earnings: A Retained earnings is one of the sources of finance for investment proposal; it is different from other sources like debt, equity and preference shares. Cost of retained earnings is the same as the cost of an equivalent fully subscripted issue of additional shares, which is measured by the cost of equity capital.

Measurement of Overall Cost of Capital: It is also called as weighted average cost of capital and composite cost of capital. Weighted average cost of capital is the expected average future cost of funds over the long run found by weighting the cost of each specific type of capital by its proportion in the firms capital structure.

The computation of the overall cost of capital (Ko) involves the following steps.

(a) Assigning weights to specific costs.

(b) Multiplying the cost of each of the sources by the appropriate weights.

(c) Dividing the total weighted cost by the total weights.

2.5 Cost of Equity: Cost of equity capital is the rate at which investors discount the expected dividends of the firm to determine its share value. Conceptually the cost of equity capital (Ke) defined as the "Minimum rate of return that a firm must earn on the equity financed portion of an investment project in order to leave unchanged the market price of the shares".

Cost of equity can be calculated from the following approach:

- Dividend price (D/P) approach
- Dividend price plus growth (D/P + g) approach
- Earning price (E/P) approach
- Realized yield approach.

Dividend Price Approach: The cost of equity capital will be that rate of expected dividend which will maintain the present market price of equity shares. Dividend price approach can be measured with the help of the following formula:

$$K_e = \frac{D}{N_p}$$

Where K e = Cost of equity capital

D = Dividend per equity share

N p = Net proceeds of an equity share

Exercise 1: A company issues 10,000 equity shares of Rs. 100 each at a premium of 10%. The company has been paying 25% dividend to equity shareholders for the past five years and expects to maintain the same in the future also. Compute the cost of equity capital. Will it make any difference if the market price of equity share is Rs. 175?

Solution

$$K_e = \frac{D}{N_p}$$

$$= \frac{25}{100} \times 100$$

$$= 22.72\%$$

If the market price of a equity share is Rs. 175.

$$K_e = \frac{D}{N_p}$$

$$= \frac{25}{175} \times 100$$

$$= 14.28\%$$

2.6 The Weighted Average Method | Weighted Average Costing

The weighted average method is used to assign the average cost of production to a product. Weighted average costing is commonly used in situations where:

- Inventory items are so intermingled that it is impossible to assign a specific cost to an individual unit.
- The accounting system is not sufficiently sophisticated to track FIFO or LIFO inventory layers.
- Inventory items are so commoditized (i.e., identical to each other) that there is no way to assign a cost to an individual unit.
- When using the weighted average method, divide the cost of goods available for sale by the number of units available for sale, which yields the weighted-average cost per unit. In this calculation, the cost of goods available for sale is the sum of beginning inventory and net purchases. You then use this weighted-average figure to assign a cost to both ending inventory and the cost of goods sold.
- The net result of using weighted average costing is that the recorded amount of inventory on hand represents a value somewhere between the oldest and newest units purchased into stock. Similarly, the cost of goods sold will reflect a cost somewhere between that of the oldest and newest units that were sold during the period.
- The weighted average method is allowed under both generally accepted accounting principles and international financial reporting standards.

2.7 Average and Marginal Cost: Average cost of capital is the weighted average cost of each component of capital employed by the company. It considers weighted average cost of all kinds of financing such as equity, debt, retained earnings etc.

Marginal cost is the weighted average cost of new finance raised by the company. It is the additional cost of capital when the company goes for further rising of finance.

Historical and Future Cost: Historical cost is the cost which has already been incurred for financing a particular project. It is based on the actual cost incurred in the previous project.

Future cost is the expected cost of financing in the proposed project. Expected cost is calculated on the basis of previous experience.

Specific and Combine Cost: The cost of each sources of capital such as equity, debt, retained earnings and loans is called as specific cost of capital. It is very useful to determine the each and every specific source of capital. The composite or combined cost of capital is the combination of all sources of capital. It is also called as overall cost of capital. It is used to understand the total cost associated with the total finance of the firm.

2.8 IMPORTANCE OF COST OF CAPITAL

Computation of cost of capital is a very important part of the financial management to decide the capital structure of the business concern. The reasons are as follows

1. **Importance to Capital Budgeting Decision**: Capital budget decision largely depends on the cost of capital of each source. According to net present value method, present value of cash inflow must be more than the present value of cash outflow. Hence, cost of capital is used to capital budgeting decision.

2. **Importance to Structure Decision**: Capital structure is the mix or proportion of the different kinds of long term securities. A firm uses particular type of sources if the cost of capital is suitable. Hence, cost of capital helps to take decision regarding structure.

3. **Importance to Evolution of Financial Performance:** Cost of capital is one of the important determining which affects the capital budgeting, capital structure and value of the firm. Hence, it helps to evaluate the financial performance of the firm.

4. **Importance to Other Financial Decisions:** Apart from the above points, cost of capital is also used in some other areas such as, market value of share, earning capacity of securities etc. hence; it plays a major part in the financial management.

QUESTIONS FOR DISCUSSION

1. What is time value of money
2. Explain the sources of working capital
3. Discuss the methods of equity calculation
4. Explain the importance of cost of capital

LESSON – 3

CONTENTS

3.0 CAPITAL BUDGETING

INTRODUCTION

The word Capital refers to be the total investment of a company of firm in money, tangible and intangible assets. Whereas budgeting defined by the "Rowland and William" it may be said to be the art of building budgets. Budgets are a blue print of a plan and action expressed in quantities and manners.

The examples of capital expenditure:

1. Purchase of fixed assets such as land and building, plant and machinery, good will, etc.
2. The expenditure relating to addition, expansion, improvement and alteration to the fixed assets.
3. The replacement of fixed assets.
4. Research and development project.

Definitions: According to the definition of Charles T. Hrongreen, "capital budgeting is a long-term Planning for making and financing proposed capital out lays

According to the definition of G.C. Philippatos, "capital budgeting is concerned with the allocation of the firms source financial resources among the available opportunities.

The consideration of investment opportunities involves the comparison of the expected future streams of earnings from a project with the immediate and subsequent streams of earning from a project, with the immediate and subsequent streams of expenditure".

According to the definition of Richard and Green law, "capital budgeting is acquiring inputs with long-term return"

According to the definition of Lyrich, "capital budgeting consists in planning development of available capital for the purpose of maximizing the long-term profitability of the concern".120 Financial Management

It is clearly explained in the above definitions that a firm's scarce financial resources are utilizing the available opportunities. The overall objective of the company from is to maximize the profits and minimize the expenditure of cost.

A number of capital budgeting techniques are used in practice. They may be grouped in the following two categories: -

1. Capital budgeting techniques under certainty; and
2. Capital budgeting techniques under uncertainty

Capital budgeting techniques under certainty: Capital budgeting techniques (Investment appraisal criteria) under certainty can also be divided into following two groups:

1. Non-Discounted Cash Flow Criteria: -
    i. Pay Back Period (PBP)
    ii. Accounting Rate Of Return (ARR)
2. Discounted Cash Flow Criteria: -
    i. Net Present Value (NPV)

ii. Internal Rate of Return (IRR)

iii. Profitability Index (PI) 2

1. **Non-Discounted Cash Flow Criteria:** These are also known as traditional techniques:

a) **Pay Back Period (PBP) :** The pay back period (PBP) is the traditional method of capital budgeting. It is the simplest and perhaps, the most widely used quantitative method for appraising capital expenditure decision. Meaning: It is the number of years required to recover the original cash outlay invested in a project. There are two methods of calculating the PBP.

i. The first method can be applied when the CFAT is uniform. In such a situation the initial cost of the investment is divided by the constant annual cash flow: For example, if an investment of Rs. 100000 in a machine is expected to generate cash inflow of Rs. 20,000 p.a. for 10 years. Its PBP will be calculated using following formula:

PBP = Initial Investment/Constant annual cash flow

=100000/20000 = 5 Years

ii. The second method is used when a project's CFAT are not equal. In such a situation PBP is calculated by the process of cumulating CFAT till the time when cumulative cash flow becomes equal to the original investment outlays.

b) **Accounting/Average Rate of Return (ARR):** This method is also known as the return on investment (ROI), return on capital employed (ROCE) and is using accounting information rather than cash flow. The ARR is the ratio of the average after tax profit divided by the average investment.

Method to compute ARR: There are a number of alternative methods for calculating ARR. The most common method of computing ARR is using the following formula:

ARR=(Avg. Annual Profit after Tax/Avg. Investment)x100

2. **Discounted Cash Flow Criteria:** These are also known as modern or time adjusted techniques because all these techniques take into consideration time value of money. The different types are

   (a) **Net Present Value (NPV):** The net present value is one of the discounted cash flow or time-adjusted technique. It recognizes that cash flow streams at different time period differs in value and can be computed only when they are expressed in terms of common denominator i.e. present value. The NPV is the difference between the present value of future cash inflows and the present value of the initial outlay, discounted at the firm's cost of capital. The procedure for determining the present values consists of two stages. The first stage involves determination of an appropriate discount rate. With the discount rate so selected, the cash flow streams are converted into present values in the second stage.

   Method to compute NPV: The important steps for calculating NPV are given below.

   i. Cash flows of the investment project should be forecasted based on realistic assumptions. These cash flows are the incremental cash inflow after taxes and are inclusive of depreciation (CFAT) which is assumed to be received at the end of each year. CFAT should take into account salvage value and working capital released at the end.

   ii. Appropriate discount rate should be identified to discount the forecasted cash flows. The appropriate discount rate is the firm's opportunity cost of capital which is equal to the required rate of return expected by investors on investments of equivalent risk.

   iii. Present value (PV) of cash flows should be calculated using opportunity cost of capital as the discount rate.

   iv. NPV should be found out by subtracting present value of cash outflows from present value of cash inflows. The project should be accepted if NPV is positive (i.e. NPV >0) The NPV can be calculated with the help of equation.

   NPV = Present value of cash inflows – Initial investment

b) **Profitability Index (PI):** Profitability Index (PI) or Benefit-cost ratio (B/C) is similar to the NPV approach. PI approach measures the present value of returns per rupee

invested. It is observed in shortcoming of NPV that, being an absolute measure, it is not a reliable method to evaluate projects requiring different initial investments. The PI method provides solution to this kind of problem. It is a relative measure and can be defined as the ratio which is obtained by dividing the present value of future cash inflows by the present value of cash outlays.

PI = Present value of Cash Inflow/Initial Cash Outlay

c) **Internal Rate of Return (IRR):** This technique is also known as yield on investment, marginal productivity of capital, marginal efficiency of capital, rate of return, and time-adjusted rate of return and so on. It also considers the time value of money by discounting the cash flow streams, like NPV. While computing the required rate of return and finding out present value of cash flows-inflows as well as outflows-are not considered. But the IRR depends entirely on the initial outlay and the cash proceeds of the projects which are being evaluated for acceptance or rejection. It is, therefore, appropriately referred to as internal rate of return. The IRR is usually the rate of return that a project earns. It is the discount rate that equates the NPV of an investment opportunity with Rs.0 (because the present value of cash inflows equals the initial investment). It is the compound annual rate of return that the firm will earn if it invests in the project and receives the given cash inflows.

3.1 Capital Rationing

In the rationing the company has only limited investment the projects are selected according to the profitability. The project has selected the combination of proposal that will yield the greatest portability.

Exercise 12 Let us assume that a firm has only Rs. 20 lakhs to invest and funds cannot be provided. The various proposals along with the cost and profitability index are as follows.

Proposal Pool of the project Profitability Index

1 6, 00,000 1.46
2 2, 00,000 .098
3 10, 00,000 2.31
4 4, 00,000 1.32
5 3, 00,000 1.25

Solution

In this example all proposals expect number 2 give profitability exceeding one and are profitable investments. The total outlay required to be invested in all other (profitable) project is Rs. 25,00,000(1+2+3+4+5) but total funds available with the firm are Rs. 20 lakhs and hence the firm has to do capital combination of project within a total which has the lowest profitability index along with the profitable proposals cannot be taken.

3.2 CAPITAL BUDGETING DECISIONS

The overall objective of capital budgeting is to maximize the profitability. If a firm concentrates return on investment, this objective can be achieved either by increasing the revenues or reducing the costs. The increasing revenues can be achieved by expansion or the size of operations by adding a new product line. Reducing costs mean representing obsolete return on assets.

3.3 WORKING CAPITAL MANAGEMENT POLICY

Working Capital Management formulates policies to manage and handle efficiently; for that purpose, the management established three policies based on the relationship between Sales and Working Capital.

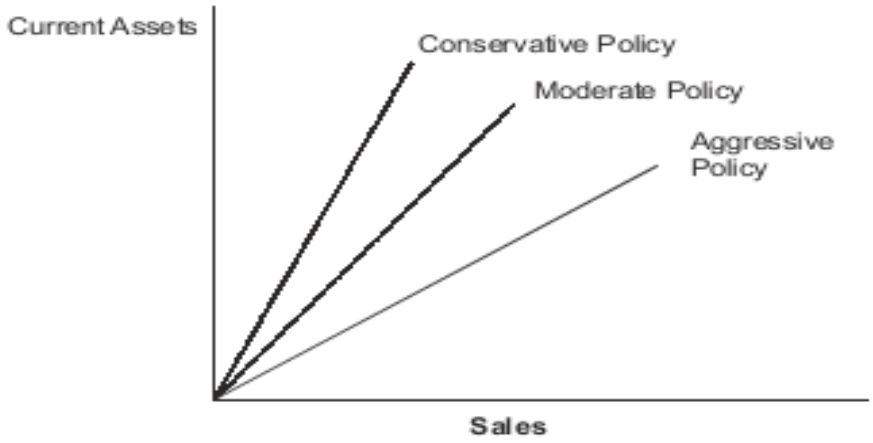
1. Conservative Working Capital Policy.
2. Moderate Working Capital Policy.
3. Aggressive Working Capital Policy.

1. **Conservative working capital policy**: Conservative Working Capital Policy refers to minimize risk by maintaining a higher level of Working Capital. This type of Working Capital Policy is suitable to meet the seasonal fluctuation of the manufacturing operation.

2. **Moderate working capital policy**: Moderate Working Capital Policy refers to the moderate level of Working Capital maintenances according to moderate level of sales. It means one percent of change in Working Capital that is Working Capital is equal to sales.

3. **Aggressive working capital policy**: Aggressive Working Capital Policy is one of the high risky and profitability policies which maintain low level of Aggressive Working

Capital against the high level of sales, in the business concern during a particular period.



3.4 CASH MANAGEMENT

Business concern needs cash to make payments for acquisition of resources and services for the normal conduct of business. Cash is one of the important and key parts of the current assets.

Cash is the money which a business concern can disburse immediately without any restriction. The term cash includes coins, currency, cheques held by the business concern and balance in its bank accounts. Management of cash consists of cash inflow and outflows, cash flow within the concern and cash balance held by the concern etc.

Motives for Holding Cash

1. **Transaction motive**: It is a motive for holding cash or near cash to meet routine cash requirements to finance transaction in the normal course of business. Cash is needed to make purchases of raw materials, pay expenses, taxes, dividends etc.

2. **Precautionary motive**: It is the motive for holding cash or near cash as a cushion to meet unexpected contingencies. Cash is needed to meet the unexpected situation like, floods strikes etc.

3. **Speculative motive**: It is the motive for holding cash to quickly take advantage of opportunities typically outside the normal course of business. Certain amount of cash is needed to meet an opportunity to purchase raw materials at a reduced price or make purchase at favorable prices.

4. **Compensating motive**: It is a motive for holding cash to compensate banks for providing certain services or loans. Banks provide variety of services to the business concern, such as clearance of cheque, transfer of funds etc.

3.5 Cash Management Techniques: Managing cash flow constitutes two important parts:

A. Speedy Cash Collections.

B. Slowing Disbursements.

Speedy Cash Collections: Business concern must concentrate in the field of Speedy Cash Collections from customers. For that, the concern prepares systematic plan and refined techniques. These techniques aim at, the customer who should be encouraged to pay as quickly as possible and the payment from customer without delay. Speedy Cash Collection business concern applies some of the important techniques as follows:

(i) **Prompt Payment by Customers**: Business concern should encourage the customer to pay promptly with the help of offering discounts, special offer etc. It helps to reduce the delaying payment of customers and the firm can avoid delays from the customers. The firms may use some of the techniques for prompt payments like billing devices, self address cover with stamp etc.

(ii) **Early Conversion of Payments into Cash**: Business concern should take careful action regarding the quick conversion of the payment into cash. For this purpose, the firms may use some of the techniques like postal float, processing float, bank float and deposit float.

(iii) **Concentration Banking**: It is a collection procedure in which payments are made to regionally dispersed collection centers, and deposited in local banks for quick clearing. It is a system of decentralized billing and multiple collection points.

(iv) **Lock Box System**: It is a collection procedure in which payers send their payment or cheques to a nearby post box that is cleared by the firm's bank. Several times that the bank deposits the cheque in the firms account. Under the lock box system, business concerns hire a post office lock box at important collection centers where the customers remit payments. The local banks are authorized to open the box and pick up the remittances received from the

customers. As a result, there is some extra savings in mailing time compared to concentration bank.

Slowing Disbursement: An effective cash management is not only in the part of speedy collection of its cash and receivables but also it should concentrate to slowing their disbursement of cash to the customers or suppliers. Slowing disbursement of cash is not the meaning of delaying the payment or avoiding the payment. Slowing disbursement of cash is possible with the help of the following methods:

1. **Avoiding the early payment of cash**: The firm should pay its payable only on the last day of the payment. If the firm avoids early payment of cash, the firm can retain the cash with it and that can be used for other purpose.

2. **Centralized disbursement system**: Decentralized collection system will provide the speedy cash collections. Hence centralized disbursement of cash system takes time for collection from our accounts as well as we can pay on the date.

3.6 Cash Management Models: Cash management models analyze methods which provide certain framework as to how the cash management is conducted in the firm. Cash management models are the development of the theoretical concepts into analytical approaches with the mathematical applications. There are three cash management models which are very popular in the field of finance.

1. **Baumol model:** The basic objective of the Baumol model is to determine the minimum cost amount of cash conversion and the lost opportunity cost. It is a model that provides for cost efficient transactional balances and assumes that the demand for cash can be predicated with certainty and determines the optimal conversion size. Total conversion cost per period can be calculated with the help of the following formula:

   Where,
   i = interest rate earned
   C/2 = Average cash balance
   Optimal cash conversion can be calculated with the help of the following formula;

$$C = \sqrt{\frac{2bT}{i}}$$

Where,

C = Optimal conversion amount

b = Cost of conversion into cash per lot or transaction

T = Projected cash requirement

i = interest rate earned

2. Miller-Orr model: This model was suggested by Miller Orr. This model is to determine the optimum cash balance level which minimizes the cost of management of cash. Miller-Orr Model can be calculated with the help of the following formula;

$$C = \frac{bE(N)}{t} + iE(M)$$

Where,

C = Total cost of cash management

b = fixed cost per conversion

E (M) = expected average daily cash balance

E (N) = expected number of conversion

t = Number of days in the period

i = lost opportunity cost

3. Orgler's model: Orgler model provides for integration of cash management with production and other aspects of the business concern. Multiple linear programming is used to determine the optimal cash management. Orgler's model is formulated, based on the set of objectives of the firm and specifying the set of constrains of the firm.

QUESTIONS FOR DISCUSSION

1. What is capital budgeting
2. Explain the working capital management policy
3. Discuss the cash management models

LESSON - 4

CONTENTS

4.0 RECEIVABLE MANAGEMENT

The term receivable is defined as debt owed to the concern by customers arising from sale of goods or services in the ordinary course of business. Receivables are also one of the major parts of the current assets of the business concerns. It arises only due to credit sales to customers, hence, it is also known as Account Receivables or Bills Receivables.

Management of account receivable is defined as the process of making decision resulting to the investment of funds in these assets which will result in maximizing the overall return on the investment of the firm. The objective of receivable management is to promote sales and profit until that point is reached where the return on investment in further funding receivables is less than the cost of funds raised to finance that additional credit.

The costs associated with the extension of credit and accounts receivables are identified as follows:

a. Collection Cost
b. Capital Cost
c. Administrative Cost
d. Default Cost.

a. **Collection Cost:** This cost incurred in collecting the receivables from the customers to whom credit sales have been made.

b. **Capital Cost** This is the cost on the use of additional capital to support credit sales which alternatively could have been employed elsewhere.
c. **Administrative Cost** This is an additional administrative cost for maintaining account receivable in the form of salaries to the staff kept for maintaining accounting records relating to customers, cost of investigation etc.
d. **Default Cost** Default costs are the over dues that cannot be recovered. Business concern may not be able to recover the over dues because of the inability of the customers. Factors Considering the Receivable Size

Receivables size of the business concern depends upon various factors. Some of the important factors are as follows:

4.1 RECEIVABLES MANAGEMENT VARIOUS FACTORS

1. **Sales Level**: Sales level is one of the important factors which determine the size of receivable of the firm. If the firm wants to increase the sales level, they have to liberalize their credit policy and terms and Conditions. When the firms maintain more sales, there will be a possibility of large size of receivable.

2. **Credit Policy**: Credit policy is the determination of credit standards and analysis. It may vary from firm to firm or even some times product to product in the same industry. Liberal credit policy leads to increase the sales volume and also increases the size of receivable. Stringent credit policy reduces the size of the receivable.

3. **Credit Terms**: Credit terms specify the repayment terms required of credit receivables, depend upon the credit terms, size of the receivables may increase or decrease. Hence, credit term is one of the factors which affect the size of receivable.

4. **Credit Period**: It is the time for which trade credit is extended to customer in the case of credit sales. Normally it is expressed in terms of 'Net days'.

5. **Cash Discount**: Cash discount is the incentive to the customers to make early payment of the due date. A special discount will be provided to the customer for his payment before the due date.

6. **Management of Receivable**:It is also one of the factors which affect the size of receivable in the firm. When the management Involves systematic approaches to the receivable, the firm can reduce the size of receivable.

Exercise: The board of directors of Aravind mills limited requests you to prepare a statement showing the working capital requirements for a level of activity of 30,000 units of output for the year. The cost structure for the company's product for the above mentioned activity level is given below.

	Cost per Unit (Rs.)
Raw materials	20
Direct labour	5
Overheads	15
Total	40
Profit	10
Selling price	50

(a) Past experience indicates that raw materials are held in stock, on an average for 2 months.
(b) Work in progress (100% complete in regard to materials and 50% for labor and overheads) will be half a month's production.
(c) Finished goods are in stock on an average for 1 month.
(d) Credit allowed to suppliers: 1 month.
(e) Credit allowed to debtors: 2 months.
(f) A minimum cash balance of Rs 25,000 is expected to be maintained.
Prepare a statement of working capital requirements.

Solution
Output per annum = 30,000 units
Output per annum = 12% of 30,000 =2,500 units
Raw materials p. m. Rs. 20×2500 = 50,000
Labour p. m. Rs. 5×2,500 = 12,500
Overheads p. m. Rs. 15×2,500 = 37,500
1, 00,000

Statement of Working Capital Requirements

Particulars	Rs.	Rs.
Current assets		
Stock of raw materials (2 months) 50,000 x 2		1,00,000
Work-in-progress (1/2 months)		
Raw materials = 50,000 x ½	25,000	
Labour = 12,500 x ½ x 50/100	3,125	
Overheads = 37,500 x ½ x 50/100	9,375	
		37,500
Stock of finished goods (1 month) 1, 00,000 x 1		1,00,000
Debtors (2 month) 1,00,000 x 2		2,00,000
Cash balance required		25,000
		4,62,500
Less: current liability		
Creditors (1 month) 50,000 x 1		50,000
(Working capital required)		4,12,500

Prepare an estimate of working capital requirement from the following information of a trading concern.

Projected annual sales 10,000 units

Selling price Rs. 10 per unit

Percentage of net profit on sales 20%

Average credit period allowed to customers 8 Weeks

Average credit period allowed by suppliers 4 Weeks

Average stock holding in terms of sales requirements 12 Weeks

Allow 10 for contingencies

Statement of Working Capital Requirements

Current Assets	Rs.
Debtors (8 weeks) $\frac{80,000 \times 8}{52}$ (at cost)	12,307
Stock (12 weeks) $\frac{80,000 \times 12}{52}$	18,462
	30,770
Less: Current Liability	
Credits (4 weeks) $\frac{80,000 \times 4}{52}$	6,154
	24,616
Add 10% for contingencies	2,462
Working Capital Required	**27,078**

Solution

Working Notes

Sales = 10000×10 = Rs. 1,00,000

Profit 20% of Rs. 1,00,000 = Rs. 20,000

Cost of Sales=Rs.1,00,000 – 20,000 = Rs. 80,000

As it is a trading concern, cost of sales is assumed to be the purchases.

Exercise: Prepare an estimate of working capital requirement from the following information of a trading concern.

Projected annual sales Rs. 6,50,000

Percentage of net profit on sales 25%

Average credit period allowed to debtors 10 Weeks

Average credit period allowed by creditors 4 Weeks

Average stock holding in terms of sales requirements 8 Weeks

Allow 20% for contingencies

Statement of Working Capital Requirements

		Rs.
Current Assets		
	Debtors (10 weeks) (at cost) $\frac{5,20,000 \times 10}{52}$	1,00,000
	Stock (8 weeks) $\frac{5,20,000 \times 8}{52}$	80,000
		1,80,000
Less:	Current Liability	
	Credits (4 weeks) $\frac{5,20,000 \times 4}{52}$	40,000
		1,40,000
	Add 20% for contingencies	28,000
	(Working Capital Required)	**1,68,000**

Working Notes

Sales=Rs. 6,50,000

Profit 25/125 of Rs. 6,50,000 = Rs. 1,30,000

Cost of Sales=Rs. 6,50,000 –1,30,000=Rs. 5,20,000

As it is a trading concern, cost of sales is assumed to be the purchases.

Exercise 7

A Performa cost sheet of a company provides the following particulars:

Elements of cost

Material 35%

Direct Labors 25%

Overheads 20%

Further particulars available are:

(i) It is proposed to maintain a level of activity of 2,50,000 units.

(ii) Selling price is Rs. 10/- per unit

(iii) Raw materials are to remain in stores for an average period of one month.

(iv) Finished foods are required to be in stock for an average period of one month.

(v) Credit allowed to debtors is 3 months.

(vi) Credit allowed by suppliers is 2 months.

You are required to prepare a statement of working capital requirements, a fore cost profit and loss account and balance sheet of the company assuring that

Share Capital Rs. 12,00,000

10% Debentures Rs. 3,00,000

Fixed Assets Rs. 11,00,000

Solution

Statement of Working Capital

Particulars	Rs.	Rs.
Current Assets		
Stock of Raw Materials (1 Month)		
(5,00,000 x 35% x 1/12)		72,917
Work in process (1/2 months)		
Materials (25,00,000 x 35% x 1/24)	36,458	
Labour (25,00,000 x 25% x 1/24)	26,041	
Overheads (25,00,000 x 20% x 1/24)	20,833	83,332
Stock of finished goods (one month)		
Materials (25,00,000 x 35% x 1/12)	72,917	
Labour (25,00,000 x 25% x 1/12)	52,083	
Overheads (25,00,000 x 20% x 1/12)	41,667	1,66,667
Debtors (2 months) At cost		
Materials (25,00,000 x 35% x 3/12)	2,18,750	
Labour (25,00,000 x 25% x 3/12)	1,56,250	
Overheads (5,00,000 x 20% x 3/12)	1,25,000	5,00,000
		8,22,916
Less: Current liability		
Credits (2 Months) for raw materials		
25,00,000 x 35% x 2/12		1,45,833
Net working capital required		**6,77,083**

Forecast Profit and Loss Account

Dr.			Cr.
To Materials (25,00,000 x 35%)	8,75,000	By cost of goods sold	20,00,000
To Wages (25,00,000 x 25%)	6,25,000		
To Overheads (25,00,000 x 20%)	5,00,000		
	20,00,000		20,00,000
To Cost of goods sold	20,00,000	By Sales	25,00,000
To Gross profit	5,00,000		
	25,00,000		25,00,000
To Interest on debentures	30,000	By Gross profit	5,00,000
To Net profit	4,70,000		
	5,00,000		5,00,000

Forecast Balance Sheet

Liabilities	Rs.	Assets	Rs.
Share capital	12,00,000	Fixed Assets	11,00,000
Net profit	4,70,000	**Stock**	
10% debentures	3,00,000	Raw material	72,917
Credits	1,45,833	Work-in-process	38,458
		Finished goods	1,66,667
		Debtors	5,00,000
		Cash and Bank Balance	2,37,791
	21,15,833		21,15,833

Selva and Co. desires to purchase a business and has consulted you and one point on which you are to advise them is the average amount of working capital which will be required in the first year's working.

You have given the following estimates and instructed to add 10% to your computed figure to allow for contingencies.

(i) Amount blocked up for stocks: Figures for the year

Stocks of finished product 3,000

Stocks of stores, materials, etc., 5,000

(ii) Average credit given:

Inland sales 4 weeks credit 26,000

Export sales— 1 2 1 weeks credit 65,000

(iii) Lag in payment of wages and other outputs

Wages— 1 2 1 weeks 2, 40,000

Stocks of materials, etc. — 1 2 1 month 36,000

Rent, Royalties, etc.—4 months 8,000

Clerical staff— 1 2 1 month 60,000

Manager— 1 2 month 4,000

Miscellaneous expenses— 121 month 36,000

(iv) Payment in advance

Sundry Expenses (paid quarterly in advance) 6,000

(v) Undrawn profit on the average throughout the year 9,000

State your calculations for the average amount of working capital required.

Statement of Working Capital

Particulars	Rs.
Current Assets	
Stock of finished products	3,000
Stock of stores material, etc.	5,000
Sundry debtors	
(a) Inland (4 weeks) 2,60,000 × 4/52	20,000
(b) Export Sales (1 $\frac{1}{2}$ weeks) 65,000 × $\frac{1.5}{12}$	1,875
	21,875
Payments in advance 6,000 × ¼	1,500
	31,375
Less: Lag in payment of wages (1 $\frac{1}{2}$ weeks) 24,000 × $\frac{1.5}{12}$	6,923
Stock, Materials etc. (1 $\frac{1}{2}$ months) 8000 × $\frac{6}{12}$	4,500
Rent, Royalties, etc. (6 months) 8000 × $\frac{61}{12}$	4,000
Clerical staff (1 $\frac{1}{2}$ month) 60,000 × $\frac{1.5}{12}$	7,500
Manager ($\frac{1}{2}$ month) 4000 × $\frac{.5}{12}$	167
Miscellaneous Expenses (1 $\frac{1}{2}$ months) 36,000 × $\frac{1.5}{12}$	4,500
	27,590
Net Working Capital	3,785
Add: 10% Margin for Contingencies	379
Net working capital required	**4,164**

A Performa cost sheet of a company provides the following particulars:

Elements of Cost Amt. Per Unit (Rs.)

Raw Materials 140

Direct Labours 60

Overheads 70

Total Cost 270

Profit 30

Selling Price 300

Further particulars available are:

Raw materials are in stock on an average for one month. Materials are in process on an average for half a month. Finished goods are in stock on an average for one month.

Credit allowed by suppliers is one month – credit allowed to customers is two months. Lag in payment of wages is 11 2 weeks. Lag in payment of overhead expenses is one month. One fourth of the output is sold against cash. Cash in hand and at bank is expected to be Rs. 50,000.

You are required to prepare a statement showing the working capital needed to finance, a level of activity of 2,40,000 units of production. You may assume that production is carried on evenly throughout the year; wages and overhead accrue similarly and a time period of 4 weeks is equivalent to a month.

Note: Year = 4×12 = 48 weeks

Statement of Working Capital

Particulars	Rs.	Rs.
Current Assets		
(i) Stock of raw materials (4 weeks) 2,40,000 × $\frac{140}{48}$ = 7,00,000 × 4		28,00,000
(ii) Work in process (2 weeks)		
Raw materials 7,00,000 × 2	14,00,000	
Direct labour 2,40,000 × $\frac{60}{48}$, 3,00,000 × 2	6,00,000	
Overheads 2,40,000 × $\frac{70}{48}$	7,00,000	
350000 × 2		27,00,000
(iii) Stock of finished good (4 weeks)		
Raw Materials 7,00,000× 4	28,00,000	
Direct Labour 30,000 × 4	1,20,000	
Overheads 3,50,000 × 4	14,00,000	
		54,00,000
(iv) Sundry Debtors (8 weeks)		
Raw Materials 7,00,000 × 8 × $\frac{3}{4}$	42,00,000	
Direct Labour 3,00,000 × 8 × $\frac{3}{4}$	18,00,000	
Overheads 3,50,000 × 8 × $\frac{3}{4}$	21,00,000	81,00,000
Cash in hand and at Bank		50,000
		1,90,50,000
(–) Current Liabilities		
(i) Sundry creditors (4 weeks) 7,00,000 × 4	28,00,000	
(ii) Wages Outstanding ($1\frac{1}{2}$ weeks) 3,00,000 × $\frac{3}{2}$	4,50,000	
(iii) Lag in payment of overhead (4 weeks) 3,50,000 × 4	14,00,000	46,50,000
Net Working Capital required		**1,44,00,000**

4.2 INVENTORY MANAGEMENT

Introduction: Inventories constitute the most significant part of current assets of the business concern. It is also essential for smooth running of the business activities. A proper planning of purchasing of raw material, handling, storing and recording is to be considered as a part of inventory management. Inventory management means, management of raw materials and related items. Inventory management considers what to purchase, how to purchase, how much to purchase, from where to purchase, where to store and when to use for production etc.

Meaning: The dictionary meaning of the inventory is stock of goods or a list of goods. In accounting language, inventory means stock of finished goods. In a manufacturing point of view, inventory includes, raw material, work in process, stores, etc.

4.3 KINDS OF INVENTORIES

Inventories can be classified into five major categories.

a. **Raw Material** It is basic and important part of inventories. These are goods which have not yet been committed to production in a manufacturing business concern.

b. **Work in Progress** These include those materials which have been committed to production process but have not yet been completed.

c. **Consumables** These are the materials which are needed to smooth running of the manufacturing process.

d. **Finished Goods** These are the final output of the production process of the business concern. It is ready for consumers.

e. **Spares** It is also a part of inventories, which includes small spares and parts.

4.4 OBJECTIVES OF INVENTORY MANAGEMENT

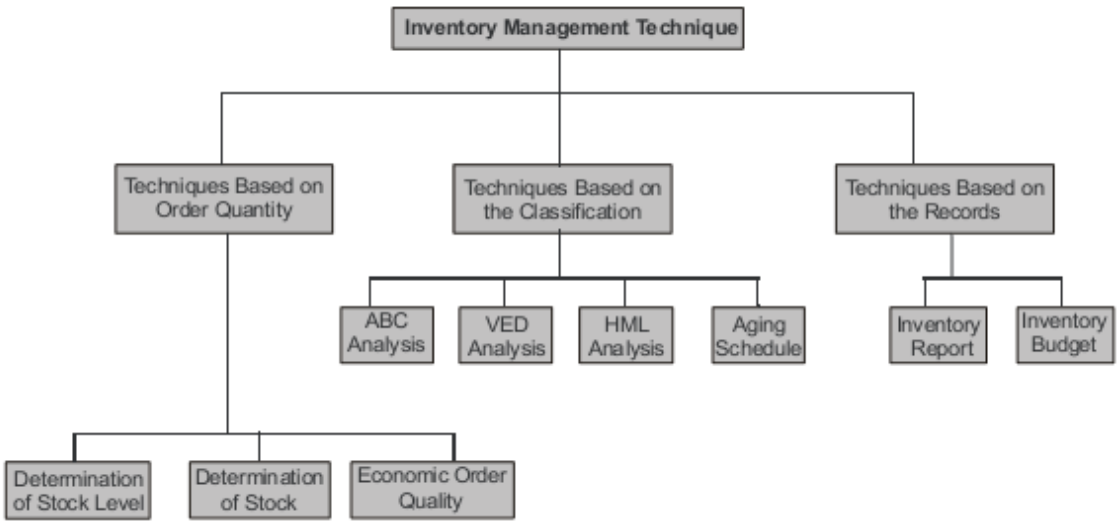
Inventory occupies 30–80% of the total current assets of the business concern. It is also very essential part not only in the field of Financial Management but also it is closely associated with production management. Hence, in any working capital decision regarding the inventories, it will affect both financial and production function of the concern. Hence, efficient management of inventories is an essential part of any kind of manufacturing process concern.

The major objectives of the inventory management are as follows:

- To efficient and smooth production process.
- To maintain optimum inventory to maximize the profitability.
- To meet the seasonal demand of the products.
- To avoid price increase in future.
- To ensure the level and site of inventories required.
- To plan when to purchase and where to purchase
- To avoid both over stock and under stock of inventory.

4.5 TECHNIQUES OF INVENTORY MANAGEMENT

Inventory management consists of effective control and administration of inventories. Inventory controls refers to a system which ensures supply of required quantity and quality of inventories at the required time and at the same time prevent unnecessary investment in inventories. It needs the following important techniques. Inventory management techniques may be classified into various types:



A. Techniques based on the order quantity of Inventories

Order quantity of inventories can be determined with the help of the following techniques:

Stock Level: Stock level is the level of stock which is maintained by the business concern at all times. Therefore, the business concern must maintain optimum level of stock to smooth running of the business process. Different level of stock can be determined based on the volume of the stock.

Minimum Level: The business concern must maintain minimum level of stock at all times. If the stocks are less than the minimum level, then the work will stop due to shortage of material.

Re-order Level: Re-ordering level is fixed between minimum level and maximum level. Re-order level is the level when the business concern makes fresh order at this level.

Re-order level=maximum consumption × maximum Re-order period.

Maximum Level: It is the maximum limit of the quantity of inventories, the business concern must maintain. If the quantity exceeds maximum level limit then it will be overstocking.

Maximum level = Re-order level + Re-order quantity

– (Minimum consumption × Minimum delivery period)

Danger Level: It is the level below the minimum level. It leads to stoppage of the production process.

$$\text{Danger level} = \text{Average consumption} \times \text{Maximum re-order period for emergency purchase}$$

Average Stock Level

It is calculated such as,

Average stock level= Minimum stock level + ½ of re-order quantity

Maximum Level

It is the maximum limit of the quantity of inventories, the business concern must maintain.

If the quantity exceeds maximum level limit then it will be overstocking.

Maximum level = Re-order level + Re-order quantity

– (Minimum consumption × Minimum delivery period)

Danger Level

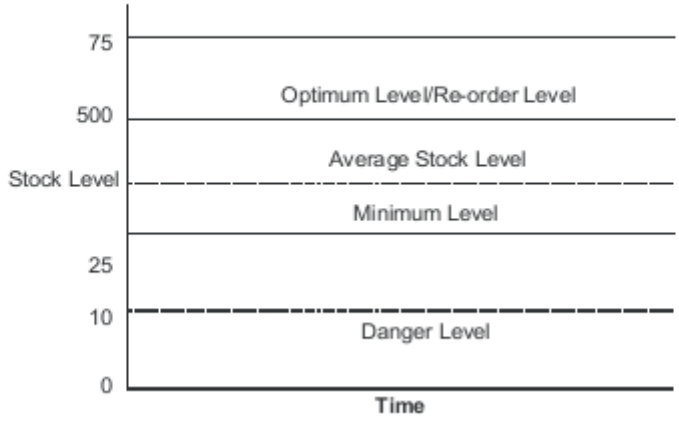
It is the level below the minimum level. It leads to stoppage of the production process.

$$\text{Danger level} = \text{Average consumption} \times \text{Maximum re-order period for emergency purchase}$$

Average Stock Level

It is calculated such as,

$$\text{Average stock level} = \text{Minimum stock level} + \frac{\text{½ of re-order quantity}}{\text{maximum level}}$$



Lead Time: Lead time is the time normally taken in receiving delivery after placing orders with suppliers. The time taken in processing the order and then executing it is known as lead time.

Safety Stock: Safety stock implies extra inventories that can be drawn down when actual lead time and/ or usage rates are greater than expected. Safety stocks are determined by opportunity cost and carrying cost of inventories. If the business concerns maintain low level of safety stock, it will lead to larger opportunity cost and the larger quantity of safety stock involves higher carrying costs.

4.6 ECONOMIC ORDER QUANTITY (EOQ)

EOQ refers to the level of inventory at which the total cost of inventory comprising ordering cost and carrying cost. Determining an optimum level involves two types of cost such as ordering cost and carrying cost. The EOQ is that inventory level that minimizes the total of ordering of carrying cost.

EOQ can be calculated with the help of the mathematical formula:

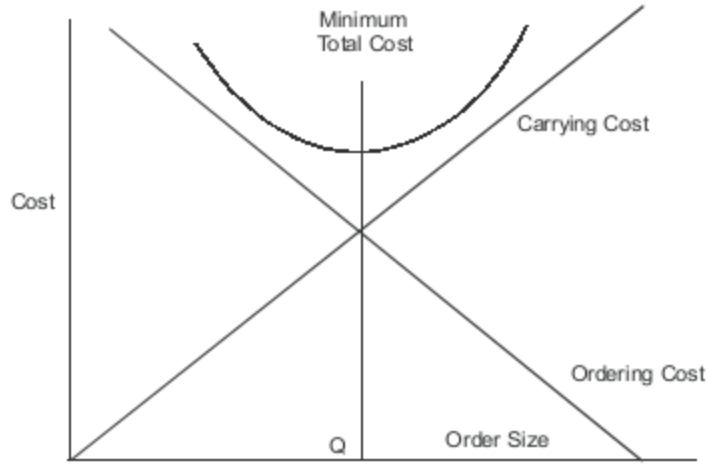
$$\text{EOQ} = \sqrt{2ab/c}$$

Where,

a = Annual usage of inventories (units)

b = Buying cost per order

c = Carrying cost per unit



Exercise 1

(a) Find out the economic order quantity and the number of orders per year from the following information:

Annual consumption: 36,000 units

Purchase price per units: Rs. 54

Ordering cost per order: Rs. 150

Inventory carrying cost is 20% of the average inventory.

Solution

$$\text{Inventory} = \sqrt{\frac{2AO}{C}}$$

$$A = 36{,}000 \text{ units}$$

$$O = \text{Rs. } 150$$

$$C = 20\% \text{ of } 54 \times 10 \times 8$$

$$\sqrt{2 \times 36{,}000 \times 150} = 1{,}000 \text{ units}$$

$$EOQ = 1{,}000 \text{ units}$$

QUESTIONS FOR DISCUSSION

1. What is receivable management
2. What is inventory management
3. Explain the techniques of inventory management

LESSON -5

CONTENTS

5.0 FINANCIAL PLANNING

Financial planning is about planning and organizing the future business activities of a firm. Planning is the managerial function that involves the selection, from amongst the various alternatives of future objectives, procedures, policies and programs.[10] Financial planning determines the direction for future growth of the business. It helps to establish the basic premises for fund procurement and utilization for value creation. Effective financial planning helps to establish future business plans for the firm like expansion, diversification or restructuring, etc.

Financial planning is a predetermination of "future course of action" and encompasses the following activities:

- Translating the mission, vision and objectives of the firm into quantifiable, measurable terms.
- Predetermine the policies and functional structures of the firm for attainment of its objectives.
- Laying down the detailed procedures, guidelines and the activities to be pursued for moving the firm in the desired direction.

Financial planning lays down the realistic financial goals and, further, establishes the financial policies and procedures to attain these goals. Financial planning is all about long-term investment decisions, budgeting, financial decisions and cost benefit analysis of a firm.

5.1 STEPS IN FINANCIAL PLANNING

The following are the steps in financial planning:

1. Setting the financial goals: Financial planning starts with establishing the financial goals for the overall firm and the various departments like cost reduction, increasing market share by 5 per cent and so on.
2. Establishing the financial policies related to various financial activities: Once the feasible and realistic target financial goals are set, the firm is all set to lay down policies regarding the various activities and course of action to be pursued to achieve the set targets.
3. Establishing the financial procedures for attainment of financial goals: The next step is to establish the financial procedures to be undertaken to attain the financial goals.
4. Monitoring the financial plan: Once the plan is implemented, the firm needs to monitor the progress. Both online monitoring as well as post-activity monitoring are beneficial to control any deviations.

5.2 TOOLS OF FINANCIAL PLANNING

Financial planning includes various tools that can be used for financial analysis; some of them are as follows:

- **Financial statements:** Financial statements such as the forecasted balance sheet, the statement of income and the cash flow statement assist in the financial planning of a firm.
- **Ratio analysis:** A tool that helps investors, analysts and management to evaluate the business performance and compare it with its competitors, for a single year period or series of years.
- **Cost–volume–profit (CVP) analysis:** CVP analysis establishes the relationship among the costs incurred, volume produced and profits generated by the firm. The

CVP uses the concept of break-even point to ascertain the desired profits, target sales and margin of safety for the firm.

- **Budgeting:** Budgeting involves forecasting future fund requirement for different activities of the firm. This helps the fund raising process of the firm.

5.3 LIMITATIONS OF FINANCIAL PLANNING

The limitations of financial planning are as follows:

- **The future is uncertain:** The financial plan is all about achieving the future objectives. The plan envisages the underlying premises that form the base for laying down the financial plan. However, it is important to understand that these assumptions are forecasts for future; and future is uncertain.
- **Problems with information use:** Not all firms are able to make effective use of available information. Many a time, relevant information is not available or accessible; and sometimes, relevant information is not available at the right time. With such information asymmetries, problems may arise in the implementation of the financial plan.
- **Flexibility of the management:** The management has to be flexible enough to incorporate changes that occur with the passage of time. No financial plan can be rigid and static. There is a need to have a flexible approach while dealing with the implementation of any financial plan.
- **Dispute amongst the management:** There should be harmony and coordination amongst the various goals and objectives of the various departments of the firm. In case dispute arises amongst the different divisions and departments, they may be vis-à-vis the implementation of the financial plan and its outcome.
- **Lack of feed-forward control mechanism:** A feed forward control mechanism is similar to online monitoring. Absence of feed forward control system affects the implementation of the financial plan negatively.

5.4 FINANCIAL STATEMENT:

INTRODUCTION: A financial statement is an official document of the firm, which explores the entire financial information of the firm. The main aim of the financial statement

is to provide information and understand the financial aspects of the firm. Hence, preparation of the financial statement is important as much as the financial decisions.

MEANING AND DEFINITION: According to Hamptors John, the financial statement is an organized collection of data according to logical and consistent accounting procedures. Its purpose is to convey an understanding of financial aspects of a business firm. It may show a position at a moment of time as in the case of a balance-sheet or may reveal a service of activities over a given period of time, as in the case of an income statement. Financial statements are the summary of the accounting process, which provides useful information to both internal and external parties.

John N. Nyer also defines it "Financial statements provide a summary of the accounting of a business enterprise, the balance-sheet reflecting the assets, liabilities and capital as on a certain data and the income statement showing the results of operations during a certain period".

5.5 FINANCIAL STATEMENTS GENERALLY CONSIST OF TWO IMPORTANT STATEMENTS

(i) The income statement or profit and loss account.

(ii) Balance sheet or the position statement.

A part from that, the business concern also prepares some of the other parts of statements, which are very useful to the internal purpose such as:

(i) Statement of changes in owner's equity.

(ii) Statement of changes in financial position.

Financial Statement

- Income Statement Position Statement
- Statement of changes in Owner's Equity
- Statement of changes in Financial Position

Income Statement Income statement is also called as profit and loss account, which reflects the operational position of the firm during a particular period. Normally it consists of one accounting year. It determines the entire operational performance of the concern like total revenue generated and expenses incurred for earning that revenue. Income statement helps to

ascertain the gross profit and net profit of the concern. Gross profit is determined by preparation of trading or manufacturing a/c and net profit is determined by preparation of profit and loss account.

Position Statement Position statement is also called as balance sheet, which reflects the financial position of the firm at the end of the financial year. Position statement helps to ascertain and understand the total assets, liabilities and capital of the firm. One can understand the strength and weakness of the concern with the help of the position statement.

Statement of Changes in Owner's Equity It is also called as statement of retained earnings. This statement provides information about the changes or position of owner's equity in the company. How the retained earnings are employed in the business concern. Nowadays, preparation of this statement is not popular and nobody is going to prepare the separate statement of changes in owner's equity.

Statement of Changes in Financial Position Income statement and position statement shows only about the position of the finance, hence it can't measure the actual position of the financial statement. Statement of changes in financial position helps to understand the changes in financial position from one period to another period. Statement of changes in financial position involves two important areas such as fund flow statement which involves the changes in working capital position and cash flow Statement which involves the changes in cash position.

QUESTIONS FOR DISCUSSION

1. What is financial planning
2. Explain the tools for financial planning
3. Discuss the financial statement analysis

LESSON - 6

CONTENTS

6.0 FINANCIAL STATEMENT ANALYSIS

Analysis of Financial Statement is also necessary to understand the financial positions during a particular period. According to Myres, "Financial statement analysis is largely a study of the relationship among the various financial factors in a business as disclosed by a single set of statements and a study of the trend of these factors as shown in a series of statements". Analysis of financial statement may be broadly classified into two important types on the basis of material used and methods of operations.

6.1 TYPES OF FINANCIAL ANALYSIS

- On the basis of Materials Used
- On the basis of Methods of Operations
- External Analysis
- Internal Analysis
- Horizontal Analysis
- Vertical Analysis

6.2 TYPES OF FINANCAIL STATEMENT ANALYSIS

1. Based on Material Used Based on the material used, financial statement analysis may be classified into two major types such as External analysis and internal analysis.

a) **External Analysis** Outsiders of the business concern do normally external analyses but they are indirectly involved in the business concern such as investors, creditors, government organizations and other credit agencies. External analysis is very much useful to understand the financial and operational position of the business concern. External analysis mainly depends on the published financial statement of the concern. This analysis provides only limited information about the business concern.

b) **Internal Analysis** The company itself does disclose some of the valuable information's to the business concern in this type of analysis. This analysis is used to understand **14** Financial Management the operational performances of each and every department and unit of the business concern. Internal analysis helps to take decisions regarding achieving the goals of the business concern.

2. Based on Method of Operation Based on the methods of operation, financial statement analysis may be classified in to two major types such as horizontal analysis and vertical analysis.

a. Horizontal Analysis: Under the horizontal analysis, financial statements are compared with several years and based on that, a firm may take decisions. Normally, the current year's figures are compared with the base year (base year is consider as 100) and how the financial information are changed from one year to another. This analysis is also called as dynamic analysis.

b. Vertical Analysis: Under the vertical analysis, financial statements measure the quantities relationship of the various items in the financial statement on a particular period. It is also called asstatic analysis, because, this analysis helps to determine the relationship with various items appeared in the financial statement. For example, a sale is assumed as 100 and other items are converted into sales figures.

6.3 TECHNIQUES OF FINANCIAL STATEMENT ANALYSIS

Financial statement analysis is interpreted mainly to determine the financial and operational performance of the business concern. A number of methods or techniques are used to

Analyze the financial statement of the business concern. The following are the common methods or techniques, which are widely used by the business concern.

Techniques

- ❖ Ratio Analysis
- ❖ Comparative Statement

- Trend Analysis
- Cash Flow Statement
- Funds Flow Statement
- Common Size Analysis

Techniques of Financial Statement Analysis

1. Comparative Statement Analysis
    a. Comparative Income Statement Analysis
    b. Comparative Position Statement Analysis
2. Trend Analysis
3. Common Size Analysis
4. Fund Flow Statement
5. Cash Flow Statement
6. Ratio Analysis

Comparative Statement Analysis Comparative statement analysis is an analysis of financial statement at different period of time. This statement helps to understand the comparative position of financial and operational performance at different period of time. Comparative financial statements again classified into two major parts such as comparative balance sheet analysis and comparative profit and loss account analysis.

Comparative Balance Sheet Analysis Comparative balance sheet analysis concentrates only the balance sheet of the concern at different period of time. Under this analysis the balance sheets are compared with previous year's figures or one-year balance sheet figures are compared with other years. Comparative balance sheet analysis may be horizontal or vertical basis. This type of analysis helps to understand the real financial position of the concern as well as how the assets, liabilities and capitals are placed during a particular period.

Comparative Profit and Loss Account Analysis Another comparative financial statement analysis is comparative profit and loss account analysis. Under this analysis, only profit and loss account is taken to compare with previous year's figure or compare within the statement. This analysis helps to understand the operational performance of the business concern in a given period. It may be analyzed on horizontal basis or vertical basis.

Trend Analysis The financial statements may be analyzed by computing trends of series of information. It may be upward or downward directions which involve the percentage relationship of each and every item of the statement with the common value of 100%. Trend analysis helps to understand the trend relationship with various items, which appear in the financial statements. These percentages may also be taken as index number showing relative changes in the financial information resulting with the various period of time. In this analysis, only major items are considered for calculating the trend percentage.

Common Size Analysis Another important financial statement analysis techniques are common size analysis in which figures reported are converted into percentage to some common base. In the balance sheet the total assets figures is assumed to be 100 and all figures are expressed as a percentage of this total. It is one of the simplest methods of financial statement analysis, which reflects the relationship of each and every item with the base value of 100%.

FUNDS FLOW STATEMENT Funds flow statement is one of the important tools, which is used in many ways. It helps to understand the changes in the financial position of a business enterprise between the beginning and ending financial statement dates. It is also called as statement of sources and uses of funds. Institute of Cost and Works Accounts of India, funds flow statement is defined as "a statement prospective or retrospective, setting out the sources and application of the funds of an enterprise. The purpose of the statement is to indicate clearly the requirement of funds and how they are proposed to be raised and the efficient utilization and application of the same".

CASH FLOW STATEMENT Cash flow statement is a statement which shows the sources of cash inflow and uses of cash out-flow of the business concern during a particular period of time. It is the statement, which involves only short-term financial position of the business concern. Cash flow statement provides a summary of operating, investment and financing cash flows and reconciles them with changes in its cash and cash equivalents such as marketable securities. Institute of Chartered Accountants of India issued the Accounting Standard (AS-3) related to the preparation of cash flow statement in 1998.

RATIO ANALYSIS Ratio analysis is a commonly used tool of financial statement analysis. Ratio is a mathematical relationship between one numbers to another number. Ratio is used

as an index for evaluating the financial performance of the business concern. An accounting ratio shows the mathematical relationship between two figures, which have meaningful relation with each other. Ratio can be classified into various types. Classification from the point of view of financial management is as follows:

- Liquidity Ratio
- Activity Ratio
- Solvency Ratio
- Profitability Ratio

Liquidity Ratio It is also called as short-term ratio. This ratio helps to understand the liquidity in a business which is the potential ability to meet current obligations. This ratio expresses the relationship between current assets and current assets of the business concern during a particular period.

Activity Ratio It is also called as turnover ratio. This ratio measures the efficiency of the current assets and liabilities in the business concern during a particular period. This ratio is helpful to understand the performance of the business concern.

6.4 LEVERAGES

INTRODUCTION Financial decision is one of the integral and important parts of financial management in any kind of business concern. A sound financial decision must consider the board coverage of the financial mix (Capital Structure), total amount of capital (capitalization) and cost of capital (Ko). Capital structure is one of the significant things for the management, since it influences the debt equity mix of the business concern, which affects the shareholder's return and risk. Hence, deciding the debt-equity mix plays a major role in the part of the value of the company and market value of the shares. The debt equity mix of the company can be examined with the help of leverage.

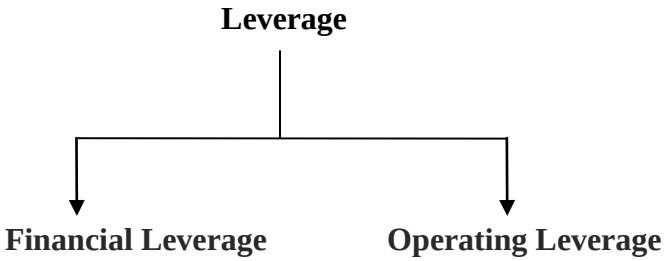
Meaning of Leverage The term leverage refers to an increased means of accomplishing some purpose. Leverage is used to lifting heavy objects, which may not be otherwise possible. In the financial point of view, leverage refers to furnish the ability to use fixed cost assets or funds to increasethe return to its shareholders.

Definition of Leverage

James Horne has defined leverage as, "the employment of an asset or fund for which the firm pays a fixed cost or fixed return.

6.5 TYPES OF LEVERAGE

Leverage can be classified into three major headings according to the nature of the finance mix of the company.



The company may use finance or leverage or operating leverage, to increase the EBIT and EPS.

FINANCIAL LEVERAGE: Leverage activities with financing activities are called financial leverage. Financial leverage represents the relationship between the company's earnings before interest and taxes (EBIT) or operating profit and the earning available to equity shareholders. Financial leverage is defined as "the ability of a firm to use fixed financial charges to magnify the effects of changes in EBIT on the earnings per share". It involves the use of funds obtained at a fixed cost in the hope of increasing the return to the shareholders. "The use of long-term fixed interest bearing debt and preference share capital along with share capital is called financial leverage or trading on equity". Financial leverage may be favorable or unfavorable depends upon the use of fixed cost funds. Favourable financial leverage occurs when the company earns more on the assets purchased with the funds, then the fixed cost of their use. Hence, it is also called as positive financial leverage. Unfavourable financial leverage occurs when the company does not earn as much as the funds cost. Hence, it is also called as negative financial leverage.

OPERATING LEVERAGE: The leverage associated with investment activities is called as operating leverage. It is caused due to fixed operating expenses in the company. Operating leverage may be defined as the company's ability to use fixed operating costs to magnify the effects of changes in sales on its earnings before interest and taxes. Operating leverage consists of two important costs viz., fixed cost and variable cost. When the company is said

to have a high degree of operating leverage if it employs a great amount of fixed cost and smaller amount of variable Cost. Thus, the degree of operating leverage depends upon the amount of various costs Structure. Operating leverage can be determined with the help of a break even analysis.

6.5 WORKING CAPITAL LEVERAGE

One of the new models of leverage is working capital leverage which is used to locate the investment in working capital or current assets in the company. Working capital leverage measures the sensitivity of return in investment of charges in the level of current assets.

6.6 BREAK EVEN ANALYSIS

Break-even analysis is used as an important planning and controlling technique. Breakeven charts and break-even analysis have become widespread and known within no time and they are extensively employed by executives in organisations, investment agencies, labour unions, and government agencies. Break-even analysis has become useful in price determination and expense control in several organisations.

According to Joel Dean, "break analysis produces flexible projections of the impact of the output rate upon expenses receipts, and profits assuming other things equal. In this way; it provides an important bridge between business behaviour and theory of firm.

QUESTIONS FOR DISCUSSION

1. Explain the types techniques of financial statement analysis
2. Discuss the types of leverage
3. What is break even analysis

LESSON – 7

CONTENTS

7.0 PRODUCTION AND OPERATIONS MANAGEMENT

INTRODUCTION

Production/operations management is the process, which combines and transforms various resources used in the production/operations subsystem of the organization into value added product/services in a controlled manner as per the policies of the organization. Therefore, it is that part of an organization, which is concerned with the transformation of a range of inputs into the required (products/services) having the requisite quality lev

The set of interrelated management activities, which are involved in manufacturing certain products, is called as production management. If the same concept is extended to services management, then the corresponding set of management activities is called as operations management.

PRODUCTION MANAGEMENT

Production management is a process of planning, organizing, directing and controlling the activities of the production function. It combines and transforms various resources used in the production subsystem of the organization into value added product in a controlled manner as per the policies of the organization.

E.S. Buffa defines production management as, “Production management deals with decision making related to production processes so that the resulting goods or services are produced

according to specifications, in the amount and by the schedule demanded and out of minimum cost."

7.1 OPERATIONS MANAGEMENT

Managing operations can be enclosed in a frame of general management function as shn in Operation managers are concerned with planning, organizing, and controlling the activities which affect human behaviour through models.

PLANNING: Activities that establishes a course of action and guide future decision-making is planning. The operations manager defines the objectives for the operations subsystem of the organization, and the policies, and procedures for achieving the objectives. This stage includes clarifying the role and focus of operations in the organization's overall strategy. It also involves product planning, facility designing and using the conversion process.

ORGANIZING: Activities that establishes a structure of tasks and authority. Operation managers establish a structure of roles and the flow of information within the operations subsystem. They determine the activities required to achieve the goals and assign authority and responsibility for carrying them out.

CONTROLLING: Activities that assure the actual performance in accordance with planned performance. To ensure that the plans for the operations subsystems are accomplished, the operations manager must exercise control by measuring actual outputs and comparing them to planned operations management. Controlling costs, quality, and schedules are the important functions here.

BEHAVIOUR: Operation managers are concerned with how their efforts to plan, organize, and control affect human behaviour. They also want to know how the behaviour of subordinates can affect management's planning, organizing, and controlling actions. Their interest lies in decision-making behaviour.

MODELS

As operation managers plan, organize, and control the conversion process, they encounter many problems and must make many decisions. They can simplify their difficulties using models like aggregate planning models for examining how best to use existing capacity in short-term, break even analysis to identify break even volumes, linear programming and computer simulation for capacity utilization, decision tree analysis for long-term capacity

problem of facility expansion, simple median model for determining best locations of facilities etc.

7.2 SCOPE OF PRODUCTION AND OPERATIONS MANAGEMENT

Production and operations management concern with the conversion of inputs into outputs, using physical resources, so as to provide the desired utilities to the customer while meeting the other organizational objectives of effectiveness, efficiency and adoptability. It distinguishes itself from other functions such as personnel, marketing, finance, etc., by its primary concern for 'conversion by using physical resources.' Following are the activities which are listed under production and operations management functions:

1. Location of facilities
2. Plant layouts and material handling
3. Product design
4. Process design
5. Production and planning control
6. Quality control
7. Materials management
8. Maintenance management.

LOCATION OF FACILITIES: Location of facilities for operations is a long-term capacity decision which involves a long term commitment about the geographically static factors that affect a business organization. It is an important strategic level decision-making for an organization. It deals with the questions such as 'where our main operations should be based?' The selection of location is a key-decision as large investment is made in building plant and machinery. An improper location of plant may lead to waste of all the investments made in plant and machinery equipments. Hence, location of plant should be based on the company's expansion plan and policy, diversification plan for the products, changing sources of raw materials and many factors. The purpose of the location study is to find the optimal location that will results in the greatest advantage to the organization.

7.2 ECONOMIC BATCH QUANTITY

Economic batch quantity (EBQ), also called "optimal batch quantity" or economic production quantity, is a measure used to determine the quantity of units that can be produced at minimum average costs in a given batch or production run. Economic Production Quantity

model (also known as the EPQ model) is an extension of the Economic Order Quantity model. The Economic Batch Quantity model, or production lot-size model, is similar to the EOQ model in that an optimum is to be calculated for the batch quantity to be produced.

In working with this EBQ model, principal assumptions are:

- The demand (D) is known and constant within a certain period of time.
- The unit cost of the inventory item (U) is constant.
- The annual holding-cost per unit (Ch) is constant.
- The setup-cost per batch (C) is constant.
- The production time (tp) is known and constant.
- There is one kind of product.
- There is no interaction with other products.
- The aspect of time does not play a role, just the setup time does.
- The setup cost is constant and does not act upon the batch quantity.
- Variables
- K = setup cost
- D = demand rate
- F = holding cost
- T = cycle length
- P = production rate

Formula:

$$\text{Economic batch quantity} = \sqrt{\frac{2 \cdot \text{annual demand} \cdot \text{setup costs}}{\text{inventory carrying cost per unit}}}$$

7.3 LAYOUT

For many people the issues of layout and flow are the most important within the general area design in operations management. This is because the way facilities are positioned relative to each other has an important effect on so many aspects of operations. First, it affects the total distance travelled by materials, information or customers as they move through the operation. Generally, layouts try and minimize distance travelled. Second, layout can affect quality. If materials or information or customers are continually being passed from one part of the operation to another there will be many points at which damage (or annoyance) can occur. Third, layout will affect throughput time. The further the distance travelled, the longer it takes to get through the operation. Fourth, layout can affect how much space is necessary for

the operation. Space costs money. Consider a financial services operation in a high cost location such London. Every square meter is important so a compact layout can save costs.

7.4 BASIC LAYOUT TYPES

The chapter describes four basic layout types. Remember though, at the end of doing this the chapter does make the point that most layout types are hybrids of two or more of these four basic types. Nevertheless it is important to understand each of them so that their advantages and disadvantages can be identified.

Fixed position layout: Unusually, in a fixed position layout the resources travel to the product or customer rather than the other way round. Several examples are mentioned in the text. An additional one is the production of movies. Most movies are shot in a studio and on location. In both cases resources centre around a fixed position (the studio set or the location). This is because moving the actors, technicians, cameras etc. to the set or location is considerably easier than the other way round.

Process layout: Process layouts are sometimes called functional layouts because the transforming resources with the same, or similar, function are grouped together. 'Products' with different requirements move between the clusters of transforming resources in different ways. This makes this kind of layout particularly flexible. It can usually cope with a wide variety of different processing requirements. However, it is complex to manage with flows crossing each other and moving on irregular and intermittent paths.

Cell layout: Primarily this type of layout is an attempt to reduce the complexity of process layouts. It divides transforming resource up into small clusters which can be used to act upon different products or product groups. Within each cell layout can be almost identical to product layout (treated next).

Product layout: Here the transforming resources are arranged for the convenience of product flow. It is the processing requirements of a particular product or service which dictates exactly where and in what order facilities are located. The classic image of the assembly line is typical of how we think of product layouts. In fact this type of layout is also common in many service industries, especially the 'back office' of services such as banks and insurance companies.

7.5 DETAILED LAYOUT DESIGN

Several techniques are described in the chapter. It is not worth repeating those here but it is worth making one important point. Most techniques are inevitably simplifications. They are intended to provide the underlying principles which help in putting a layout together. In practice, there are nearly always more considerations than those which can be included in a particular technique. For example, considerations of safety will always need to be included in layout decisions but often these are brought into the decision making process after an initial layout has been suggested by using one of the techniques. This suggested layout is then modified to ensure full compliance with safety considerations.

QUESTIONS FOR DISCUSSION

1. What is layout
2. What is economic order quantity
3. Explain the types of layout

LESSON – 8

CONTENTS

8.0 CAPACITY PLANNING

Capacity Planning: The production system design planning considers input requirements, conversion process and output. After considering the forecast and long-term planning organization should undertake capacity planning.

Capacity is defined as the ability to achieve, store or produce. For an organization, capacity would be the ability of a given system to produce output within the specific time period. In operations, management capacity is referred as an amount of the input resources available to produce relative output over period of time.

In general, terms capacity is referred as maximum production capacity, which can be attained within a normal working schedule.

Capacity planning is essential to be determining optimum utilization of resource and plays an important role decision-making process, for example, extension of existing operations, modification to product lines, starting new products, etc.

1. Strategic Capacity Planning: A technique used to identify and measure overall capacity of production is referred to as strategic capacity planning. Strategic capacity planning is utilized for capital intensive resource like plant, machinery, labor, etc.

   Strategic capacity planning is essential as it helps the organization in meeting the future requirements of the organization. Planning ensures that operating cost are

maintained at a minimum possible level without affecting the quality. It ensures the organization remain competitive and can achieve the long-term growth plan.

2. **Capacity Planning Classification:** Capacity planning based on the timeline is classified into three main categories long range, medium range and short range.

1. Long Term Capacity: Long range capacity of an organization is dependent on various other capacities like design capacity, production capacity, sustainable capacity and effective capacity.

a. Design capacity is the maximum output possible as indicated by equipment manufacturer under ideal working condition.
b. Production capacity is the maximum output possible from equipment under normal working condition or day.
c. Sustainable capacity is the maximum production level achievable in realistic work condition and considering normal machine breakdown, maintenance, etc.
d. Effective capacity is the optimum production level under pre-defined job and work-schedules, normal machine breakdown, maintenance, etc.

2. Medium Term Capacity: The strategic capacity planning undertaken by organization for 2 to 3 years of a time frame is referred to as medium term capacity planning.

3. Short Term Capacity: The strategic planning undertaken by organization for a daily weekly or quarterly time frame is referred to as short term capacity planning.

Goal of Capacity Planning: The ultimate goal of capacity planning is to meet the current and future level of the requirement at a minimal wastage. The three types of capacity planning based on goal are lead capacity planning, lag strategy planning and match strategy planning.

8.1 PROCESS PLANNING

Process Planning: A process is a set of steps that result in a specific outcome. For example, a customer service request might have the following steps:

Customer requests service:

- Service department enters request into a tracking system
- The request is routed to the repair department

- A repair technician is assigned to evaluate the request and to respond to the customer
- A technician is dispatched, if appropriate
- Once the response is made, a survey is sent to the customer to confirm their issue was resolved

In this case, the process is response to customer service request, and the outcome is resolution of the customer's problem.

Goal of Process Planning: The goal of process planning is to improve and streamline the business methods of a company. This would have results like:

- Lower costs, due to fewer staff needed to complete the same process
- Higher efficiency, by eliminating problematic process steps like loops and bottlenecks
- Higher accuracy, by including checkpoints and success measures to make sure process steps are completed accurately
- Greater understanding by all staff of what they need to do to meet their department objectives

Principles of Process Planning: Here are some general principles to keep in mind when evaluating or improving processes:

- First, define the outputs, and then look toward the inputs needed to achieve those outputs.
- Define the goals of the process and evaluate them regularly to make sure they are still appropriate. This would include specific measures like quality scores and turnaround times.
- When mapped, the process should appear as a logical flow, without loops back to earlier steps or departments.
- Any step performed needs to be included in the documentation. If not, it should be eliminated or documented, depending on whether or not it's necessary to the process.
- People involved in the process should be consulted, because they often have the most current information on what works and what does not.

Steps to Plan a Process: Process planning involves the definition, documentation, review and improvement of steps in business processes used at a company. Each of these steps will be described below.

1. **Goal setting:** Now whenever we plan something we have some goal in our mind that we have to achieve or something that we want to do. These are called goals or targets. In organizations also there are some goals around which the efforts of the managers and executives revolves. These goals should be clear and measurable so that the efforts made against those goals should be evaluated easily. Goals should not be rigid that is they should be flexible and can be modified, if needed. More, the goals should be information and self motivating so that the executives and the managers should not feel fallen into a rigid process.
2. **Identify available resources:** Once the goals are set the next step is to identify the available resources in the organization to analyze whether the available resources are enough or its need to have some more. Analyzing available resources means to take into account all the resources including monetary resources, sales people, technical resources, etc. This helps managers to make necessary arrangements for future needs, so that the required resources should be available when needed.
3. **Creating steps and strategies:** Now the next step comes with thinking in a practical way as to what will be the steps to do a particular task. For example, if the sales plans are to be made then the steps and strategies will include as to how to approach a particular client/customer, what should be proposed to him first and in what manner, there should be some alternative strategies too keeping in mind the future scenario. Also whatever the strategies will be, they should be discussed well with the executives or with the team that will be assigned that particular tasks.
4. **Review meetings:** Regular review meetings should be planned so as to check whether the plans are carried effectively. This also helps to managers to achieve their goals in time. Further the executives and the team is also aware that they are held responsible for the tasks that are assigned to them. This provides better level of control to the managers and the top management.
5. **Implement necessary steps:** If needed he managers may require changing the steps or strategies to accomplish their goals. These can be the alternative course of action or can be the solution to the present problems.

Planning process though can never be the same in all the organization. It also depends on the organization/team size as with the small teams the risk factor can be higher as they need to do their tasks in very effective way with limited resources.

8.2 ECONOMIC BATCH QUANTITY(EBQ)

Definitions: Economic Batch Quantity (EBQ), also known as the optimum production quantity (EPQ), is the order size of a production batch that minimizes the total cost.

Batch production is a technique which is commonly used today for distributing the total production in a series of small batches rather than mass producing in one go. Sometimes the production of goods in batches is necessary because, for example, certain equipment used in manufacturing (e.g. dyes) may wear out and need replacement before the production can run again.

Batch production may be desirable in other cases as well. For example, where the objects being produced are perishable, the entire production requirement for say a year can't be manufactured in a week as it might cause the goods to expire after some time. Batch production also reduces the risk of obsolescence as any minor changes required in the specification of goods (e.g. size, color, etc.) can be made in future batches according to the feedback received from customers or retailers instead of producing everything in one go and hoping for the best.

Whereas EOQ is suitable for determining the order size when the parts, materials or finished goods are ready to be delivered by external suppliers when the order is placed, EBQ is used to determine the size of a production run (i.e. batch size) when the manufacturing takes place internally and any raw materials or parts required for production are either acquired internally or are supplied incrementally by other companies according to the production requirement.

Formula:

Economic Batch Quantity = $\sqrt{(2 \times Cs \times D)/Ch(1 - D/P)}$

Where:

Cs is the setup cost of a batch

D is the annual demand

P is the annual production capacity

Ch is the annual cost of holding one unit of finished inventory

The formula for calculating EBQ is very similar to EOQ with one notable difference in the denominator. The cost of holding in EBQ formula is decreased by the amount of inventory

that will be produced and sold on the same day therefore not contributing to the annual cost of holding the inventory.

Example: Sarah owns and operates a small factory that manufactures plastic bottles which she sells to bottling companies.

Additional information:

Annual demand is 1 million bottles spread evenly over the year

Setup cost is $5000 per batch

Holding cost is $3 per annum for each bottle

Maximum production capacity is 2 million bottles per annum

Currently, bottles are manufactured in 10 batches

A. Find the optimum production quantity that Sarah should produce to minimize her costs

B. Calculate the current annual holding cost and setup cost

C. Calculate the savings to Sarah if she adopts the EBQ

Solution A: Optimum Production Quantity

Economic Batch Quantity

$= \sqrt{}(2 \times Cs \times D)/ Ch(1 - D/P)$

$= \sqrt{}(2 \times 5000 \times 1{,}000{,}000)/3 \times (1-(1{,}000{,}000/2{,}000{,}000))$

$= \sqrt{}(10{,}000{,}000{,}000)/1.5$

$= 6{,}666{,}666{,}666$

$= 81{,}650$

Sarah should manufacture bottles in batches of 81,650 units.

Solution B: Current Costs

Batch Quantity = Annual Demand ÷ Number of batches

= 1,000,000 ÷ 10

= 100,000 units

Annual Holding Cost = (Batch Quantity/2) × Ch × (1- D/P)

= (100,000/2) × 3 × (1-(1,000,000/2,000,000))

= $75,000

Setup Cost = Number of setups × setup cost

= 10 × 5000

= $50,000

Total Current Cost = ($75,000 + $50,000) = $125,000

Solution C: Savings from EBQ

Annual Holding Cost:

= (Batch Quantity/2) × Ch × (1- D/P)

= (81,650/2) × 3 × (1-(1,000,000/2,000,000))

= $61,238 (A)

Setup Cost:

Number of batches = 1,000,000 ÷ 81,650 = 12.2475

Setup Cost = Number of batches × Cost of setup

= 12.2475 × $5000 = $61,23 (B)

Total Cost (EBQ) = (A) + (B) = $122,476 (C)

Total Current Cost = 125,000 (D)

Savings = (D) - (C) = 2,524

LESSON - 9

CONTENTS

9.0 PRODUCTION PLANNING AND CONTROL

Production: It is an organized activity of converting raw materials into useful products. But before starting the actual production, production planning is done to anticipate possible difficulties and to decide in advance as to how the production process should be carried out in a best and economical way to satisfy customers. Since only planning of production is not sufficient, hence management takes all possible steps to see that plans chalked out by planning department are properly adhered to and the standard set are attained. In order to achieve it, control over production is exercised. The ultimate aim of production planning and control (PPC) is to produce the products of right quality in right quantity at the right time by using the best and least expensive methods.

Production planning and control can thus be defined as:

- The process of planning the production in advance.
- Setting the exact route of each item.
- Fixing the starting and finishing date for each item.
- To give production orders to different shops.
- To see the progress of products according to order.

Functions of PPC:

1. Forecasting: Estimation of type, quantity and quality of future work.
2. Order writing: Giving authority to one or more persons to undertake a particular job.
3. Product design: Collection of information regarding specification, bill of materials, drawing, etc.
4. Process planning and routing: Finding the most economical process of doing work and then deciding how and where the work will be done.

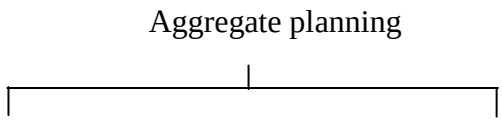
5. Material control: It involves determining the material requirement and control of materials.
6. Tool control: It involves determining the requirement and control of tools used.
7. Loading: Assignment of work to man power and machining etc.
8. Scheduling: It determines when and in what sequence the work will be carried out. It fixes the starting and finishing time for the job.
9. Dispatching: It is the transition from planning to action phase. In this phase the worker is ordered to start the actual work.
10. Progress reporting: Data regarding the job progress is collected. It is interpreted by comparison with the preset level of performance.
11. Corrective action:
    a. Expediting means taking action if the progress reporting indicates a deviation of the plan from the original set target.
    b. Replanning of the whole affair becomes essential, in case expediting fails to bring the deviation plan to its right path.

Objectives of PPC

1. To determine the sequence of operations to continue production.
2. To issue co-ordinated work schedule of production to the supervisor/foreman of various shops.
3. To plan out the plant capacity to provide sufficient facilities for future production programme.
4. To maintain sufficient raw materials for continuous production.
5. To follow up production schedule to ensure delivery promises.
6. To evaluate the performance of various shops and individuals.
7. To give authority to right person to do right job.

Aggregate Planning: The aggregate planning concentrates on scheduling production, personnel and inventory levels during intermediate term planning horizon such as 3-12 months. Aggregate plans act as an interface between strategic decision (which fixes the operating environment) and short term scheduling and control decision which guides firm's day-to-day operations. Aggregate planning typically focuses on manipulating several aspects of operations-aggregate production, inventory and personnel levels to minimize costs over

some planning horizon while satisfying demand and policy requirements. In brief the objectives of AP are to develop plans that are feasible and optimal.



Aggregate Production Planning indicates the level of output. Aggregate Capacity Planning keep capacity utilization at desired level and test the feasibility of planned output.

Decision options in Aggregate Planning: The decision options are basically of 2 types:

(i) Modification of demand for a product.

(ii) Modification of supply of a product.

(i) Modification of demand: Demand can be modified in several ways:

(a) Differential pricing: It is often used to reduce the peak demand or to increase the off period demand. Some examples are: reducing off season fan/woollen item rate, reducing the hotel rate in off season.

(b) Advertising and promotion: These methods are used to stimulate/smooth out demand. Advertising is generally so timed as to increase demand during off period and to shift demand from peak period to he off period.

(c) Backlogs: Through the creation of backlogs, the manufacturers ask customers to wait for the delivery of products, thereby shifting the demand from peak period to off period.

(d) Development of complementary products: Producer, who produces products which are highly seasonal in nature, applies this technique. Ex: Refrigerator company produce room heater, TV Company produces DVD, etc.

(ii) Modification of supply: There are various methods of modification of supply.

(a) Hiring and lay off employees: The policy varies from company to company. The man power/work force varies from peak period to slack/off period. Accordingly, firing/lay off employee is followed without affecting employee morale.

(b) Overtime and undertime: Overtime and undertime are common options used in cases of temporary change of demand.

(c) Use of part time or temporary labour: This method is attractive as the payment of part time/temporary labour is less.

(d) Subcontracting: The subcontractor may supply the entire product/some of the components needed for the product.

(e) Carrying inventories: It is used by manufacturers who produces items in a particular season and sell them throughout the year

Aggregate Planning Strategies:

Pure strategy: If the demand and supply is regulated by any one of the following strategy, i.e.

(a) Utilizing inventory through constant work force.

(b) Varying the size of workforce.

(c) Subcontracting.

(d) Making changes in demand pattern.

Mixed strategy: If the demand and supply is regulated by mixture of the strategies as mentioned, it is called mixed strategy.

9.1 SEQUENCING

Sequencing: The order in which jobs pass through the machines or work stations is called sequencing. The relative priorities are based on certain rules as discussed in the following:

1. First Come, First Served (FCFS) rule: This is a fair approach particularly applicable to people. In case of inventory management, it is First In First Out (FIFO). That means the 1^{st} piece of inventory at a storage area is the 1^{st} one to be used.
2. The shortest processing time (SPT) rule: SPT rule sequences jobs in increasing order of their processing times (including set up).
3. The Earliest Due Date (EDD) rule: Sequences jobs in order of their due dates, earliest first.
4. The critical ratio (CR) rule: Sequences jobs in increasing order of their critical ratio.

$$CR = \frac{\text{Due date- Today's date}}{\text{Remaining processing time}}$$

If CR>1 The job is ahead of schedule.

If CR<1 The job is behind schedule.

If CR=1 The job is exactly on schedule.

- The Slack Time Remaining (STR) rule: It employs that the next job processed is the one that has the least amount of slack time.

  Slack = (Due date – Today's date) – Remaining processing time

Sequencing of n jobs through 2 machines (Johnson's rule) Considering 2 machines and 'n' jobs as shown in following table

1	t11	t12
2	t21	t22
3	t31	t32
4	t11	t42
.	.	.
.	.	.
i	ti1	ti2
.	.	.
n	tn1	tn2

Step 1: Find the minimum among t_{i1} and t_{i2}.

Step 2(a): If the minimum processing time requires m/c-1, place the associated job in the 1st available position in sequence.

Step 2(b): If the minimum processing time requires machine-2, place the associated job in the last available position in sequence.

Step 3: Remove the assigned job from the table and return to Step 1 until all positions in sequence are filled. (Ties may be considered randomly)

The above algorithm is illustrated with the following example.

Ex.1 Consider two machines and six jobs flow shop scheduling problem. Using Johnson's algorithm, obtain the optimal sequence which will minimize the makespan.

Job	Time taken by machines	
	1	2
1	5	4
2	2	3
3	13	14
4	10	1
5	8	9
6	12	11
Sum	50	42

Solution: The working of the algorithm is summarized in the form of a table which is shown below.

Stage	Unscheduled job	Min	Assignment	Partial sequence/ Full sequence
1	1 2 3 4 5 6	t42	Job 4-[6]	× × × × × 4
2	1 2 3 5 6	t21	Job 2-[1]	2 × × × × 4
3	1 3 5 6	t12	Job 1-[5]	2 × × × 1 4
4	3 5 6	t51	Job 5-[2]	2 5 × × 1 4
5	3 6	t62	Job 6-[4]	2 5 × 6 1 4
6	3	t31	Job 3-[3]	2 5 3 6 1 4

Now the optimal sequence is 2-5-3-6-1-4.

The make span is determined as shown below.

Job	M/C-1		M/C-1		Idle time on m/c-2
	Time in	Time out	Time in	Time out	
2	0	2	2	5	2
5	2	10	10	19	5
3	10	23	23	37	4
6	23	35	37	48	0
1	35	40	48	52	0
4	40	50	52	53	0

The make span for this schedule is 53.

Line balancing: Plants having continuous flow process and producing large volume of standardized components prefer conveyor assembly line. Here the work centres are sequenced in such a way that at each stage a certain amount of total work is carried out so that at the end of conveyor line, the final product comes out. This requires careful preplanning to balance the timing between each work centres so that idle/waiting time is minimized. This process of internal balancing is called Assembly line balancing.

Line balancing is defined as the procedure for creating work stations and assigning tasks to them according to a predetermined technological sequence such that the idle time at each work station is minimized.

In perfect line balancing, each work centre completes its assigned work within a fixed time duration so that output from all operations are equal on the line. Such a perfect balancing is difficult to achieve. Certain work station/centre take more operation time causing subsequent work centre to become idle.

Balancing may be achieved by

- Rearrangement of work stations
- Adding m/c and or workers at some work stations.

So that all work centres take about the same amount of time.

Some terminologies used in line balancing:

1. Work station: It is a location on the assembly line where specified work is performed.
2. Cycle time: It is the amount of average time a product spends at one work station

$$\text{Cycle time (CT)} = \frac{\text{Available time period}}{\text{Total no. of products/output}}$$

3. Task : The smallest grouping of work that can be assigned to a work station.
4. Task time: Standard time to perform task.
5. Station time: Total standard time at a particular work station.

A typical example will clarify the procedure of line balancing.

Ex: A company is setting an assembly line to produce 192 units per 8 hour shift. The information regarding work elements in terms of times and intermediate predecessors are given below:

Work element	Time (Sec)	Immediate predecessor
A	40	None
B	80	A
C	30	D,E,F
D	25	B
E	20	B
F	15	B
G	120	A
H	145	G
I	130	H
J	115	C,I
Total	720	

1. What is the desired cycle time?
2. What are the theoretical numbers of stations?

3. Use largest work element time rule to work out a solution on a precedence diagram.
4. What are efficiency and balance delay of the solution obtained?
   (a) Cycle time: 8hours/192 units = 150 sec/unit.
   (b) Sum of the time of all work elements = 720 secs
   (c) So, minimum number of work station = 720/150 = 4.8 = 5 stations.

b) Assignment of work element to stations:

Station/ stations	Elements	Work element time (Sec)	Cumulative time (Sec)	Idle time for station (Sec)
S1	A	40	40	05
	B	80	120	
	D	25	145	
S2	G	120	120	10
	E	20	140	
S3	H	145	145	05
S4	I	130	130	05
	F	15	145	
S5	C	30	30	05
	J	115	145	

(d) Efficiency: $\sum t \times 100/n \times CT = 720 \times 100/5 \times 150 = 96\%$.

(e) Balance delay = 100-96 = 4%.

Flow control: Flow control applies to the control of continuous production as found in oil refineries, bottling works, cigarette making factories, paper making mills and other mass manufacturing plants.

Flow control can be performed through the following:

(a) **Operation time**: It amounts the time required to manufacture each part, to make one subassembly and to execute one assembly. This information is available from the operation sheet.

(b) **Line balancing**: the assembly line should be balanced. Each work station should have the more or less same operating time and the various operations should be sequenced properly.

(c) **Control of parts subassemblies and Assembly**: A supervisory function coupled with an appropriate information feedback system keeps a check whether the small parts arriving in lots and big parts coming continuously are

available at right time, in proper quantities for making subassemblies as per scheduled plan.

(d) Dispatching: Dispatching is nothing but issuing orders and instructions to start a particular work which has already been planned under routing and scheduling.

Functions of Dispatching

(i) Assignment of work to individual man, m/c or work place.

(ii) Release necessary order and production firm.

(iii) Authorize for issue of materials, tools, jigs, fixtures, gauges, dies for various jobs.

(iv) Required materials are authorized to move from stores or from operation to operation.

(v) Issue m/c loading and schedule chart, route sheet, etc.

(vi) To fix up the responsibilities of guiding and controlling the materials and operation processes.

(vii) To issue inspection order.

(viii) Issue of time tickets, drawing, instruction cards.

Dispatch procedure:

The various steps of dispatch procedure for each operation are listed below:

(a) Store issue order: Authorise store department to deliver required material.

(b) Tool order: Authorise tool store to release the necessary tools. The tools can be collected by the tool room attendant.

(c) Job order: Instruct the worker to proceed with operation.

(d) Time tickets: It records the beginning and ending time of the operation and forms the basis for workers pay.

(e) Inspection order: Notify the inspectors to carry out necessary inspections and report the quality of the component.

(f) Move order: Authorise the movement of materials and components for one facility to another for further operation.

In addition, there are certain dispatch aspects such as:

(1) All production information should be available beforehand.

(2) Various order cards and drawing with specification should be ready.

(3) Equipment should be ready for use.

(4) Progress of various orders should be recorded.

(5) All production records should be on Gantt chart.

Centralized and decentralized dispatching

a) Centralized Dispatching: In centralized dispatching system, a central dispatching department orders directly to the work stations. It maintains a full record of the characteristics and capacity of each equipment and work load against each m/c. The orders are given to the shop supervisor who runs his machine accordingly. In most of the cases, the supervisor can also give suggestions as regards to loading of m/cs under him. A centralized system has the following advantages:

   i. A greater degree of overall control can be achieved.
   ii. Effective coordination between different facilities is possible.
   iii. It has greater flexibility.
   iv. Because of urgency of orders, changes in the schedule can be made easily without upsetting the whole system.
   v. Progress of orders can be readily assessed at any time because all the information is available is available at a central place.
   vi. There is effective and better utilization of manpower and machines.

b) Decentralized Dispatching: In decentralized dispatching system, the shop supervisor performs the dispatch function. He/she decides the sequence of handling different orders. He/she dispatches the orders and materials to each equipment and worker, and is required to complete the work within the prescribed duration. In case he/she suspects delay, he/she informs the production control department. A centralized dispatching system has the following advantages:

   (i) Much of red tape (excessive adherence to official rules) is minimized.
   (ii) Shop supervisor knows the best about his shop.
   (iii) Communication gap is reduced.
   (iv)It is easy to solve day to day problem.

Levels of Dispatch office: At plant manager's level.

At shop superintendent level.

At shop supervisor's level.

At specialist level.

Expediting: Expediting and dispatching are frequently performed under the same agency, particularly in special project control. An expeditor follows the development of an order from the raw material stage to the finished product. He/she is often given the authority and facilities to move materials or semi-finished products to relieve congestion in production flow.

Gantt chart: HL Gantt has developed a simplified graph which represents/displays the planned starting and finishing time of each task on a time scale. But it does not show the interrelationship among the tasks. On the left of the chart is a list of the activities and along the top is a suitable time scale. Each activity is represented by a bar; the position and length of the bar reflects the start date, duration and end date of the activity. This allows you to see at a glance:

- What the various activities are
- When each activity begins and ends
- How long each activity is scheduled to last
- Where activities overlap with other activities, and by how much
- The start and end date of the whole project

Line of balance (LOB): LOB is a graphical technique used to find out the state of completion of various processes at a given time for a product. This technique is economical when the production volume is limited and applied to the production of aircrafts, missiles, heavy machines, etc.

For drawing the LOB, the following information are required:

- Contracted schedule of delivery
- Key operations in making the product.
- The sequence of key events.
- The expected/observed lead time w.r.t. delivery of final product.

Based on above information, a diagram is drawn which compares pictorically the planned verses actual progress. This is called line of balance (LOB).

Learning curve: From our everyday experience, we know that the first time we perform a skilled job, it takes much longer time than an experienced worker. But the next time if we perform the same job, we can perform it not only at faster rate but also with higher quality. Each additional time we do the same job, we become faster and better in performing. This improvement in productivity and quality of work as a job is repeated is called quality of work, as a job is repeated is called learning effect.

Similarly, when the number of units produced increases, the direct labour hours required per unit decreases for a variety of reasons such as:

(i) Workers become more and more skilled for a particular set of task.

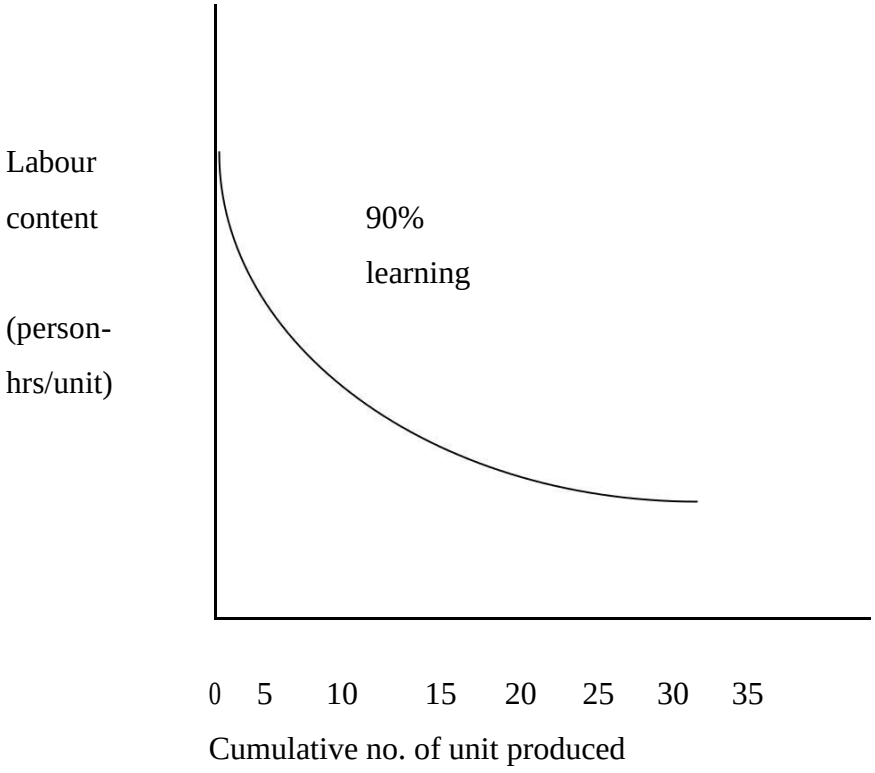
(ii) Improvement in production methods and tooling takes place.

(iii) Improvement in layout and flow takes place and many other reasons.

While designing jobs, estimating work standards, scheduling production and planning capacity, it is important to know at what rate workers productivity will increase through learning. For example, if it takes a worker 10 hours to make the first 50 units of product, we don't want to plan on it taking 10 hours for every additional 50 units. Otherwise we will underestimate our production capacity and overstaff our operations. The role of worker learning in production, its effect on production costs and ways to measure it were popularized long ago.

The rate of learning and learning curve: The labour content (in person-hrs per unit) requires to make a product, expressed as a function of the cumulative number of units made is called Learning Curve. A typical learning curve is shown below.

We normally express the rate of leraning in terms of how quickly the labour requirement decrease as we double the cumulative amount of output. We say that an activity exhibits an x% learning rate or has an x% learning curve, if the amounts of labour required to make the 2nth units of the product is x% of that required to make the nth unit.



More generally, the amount of time required to make the nth unit of the product will be

$T_n = T_1 \times n^a$

where T_n = Time to make the nth unit.

T_1 = Time to make 1st unit.

a = (ln x/ln 2)

x = learning rate (expressed as decimal)

This learning data can also be represented in tabular form.

9.2 STATISICAL TECHNIQUES IN CONTROLLING

Project: A project is an interrelated set of activities that has a definite starting and ending point and those results in a unique product. That means projects are not repetitive. Few examples of projects are:

1. Constructing a bridge, dam, highway or building.
2. Producing an airplane, missile or large machine.
3. Introducing a new product.
4. Installing a large computer system.
5. Redesigning the layout of plant or office.
6. Construction of a ship.
7. Fabrication of a steam boiler.
8. Maintenance of major equipments/Plants.

9. Commissioning of a power plant/factory.
10. Conducting National Election.

Basic steps in project management: Managing a project, regardless of its size and complexity, requires identifying every activity to be undertaken and planning when each activity must begin and end in order to complete the overall project on time. Typically, all projects involve the following steps:

1. Describe the project.
2. Develop a network model.
3. Insert time estimates.
4. Analyze the model.
5. Develop the project plan.
6. Periodically assess the progress of the project and repeat steps 2-6 as needed.

Network: A network is the graphical representation of the project activities arranged in a logical sequence and depicting all the interrelationships among them.

Terminologies used in Network diagram:

1. Activity: An activity means work/job. It is a time consuming process. It is represented by an arrow in the network diagram (AOA system).
2. Event: An event is a specific instant of time marks the start and end of an activity.
3. Critical path: It is the sequence of activities which decides the total project duration.
4. Duration (d): Duration is the estimated or actual time required to complete a task or an activity.
5. Total project time: Time to complete the project. In other words, it is the duration of critical path.
6. Earliest start time (E): It is the earliest possible time at which an activity can start. It is calculated by moving from 1^{st} to last event in the network diagram.
7. Latest start time (L_i): It is the latest possible time by which an activity can start.
8. Earliest finish time (E_j): It is the last event time of the head event. It is calculated by moving backward in the network diagram.
9. Latest finish time (L_j): It is the last event time of the head event. It is calculated by moving backward in the network diagram.
10. Float/Slack: Slack is with reference to an event and Float is with reference to an activity.

11. Free float: (Latest Finish Time – Earliest Start Time) – Activity duration.

Rules for Network Construction: The following are the primary needs for constructing Activity on Arc (AOA) network diagram.

1. The starting event and ending event of an activity are called tail and head event respectively.
2. The network should have a unique starting node. (tail event)
3. The network should have a unique completion node. (head event)
4. No activity should be represented by more than one are ( ) in the network.
5. No two activities should have the same starting node and same ending node.
6. Dummy activity is an imaginary activity indicating precedence relationship only. Duration of dummy activity is zero.
7. The length of the arrow bears no relationship to the activity time.
8. The arrow in a network identifies the logical condition of dependence.
9. The direction of arrow indicates the direction of workflow.
10. All networks are constructed logically or based on the principle of dependency.
11. No event can be reached in a project before the completion of precedence activity.
12. Every activity in the network should be completed to reach the objective.
13. No set of activities should form a circular loop.

Time estimation of an activity

If t_0 = Optimistic time (i.e. time estimate for fast activity completion). t_p = Pessimistic time (maximum time duration an activity can take). t_m = Most likely time

t_e = The expected time of an activity = $(t_0 + 4t_m + t_p)/6$

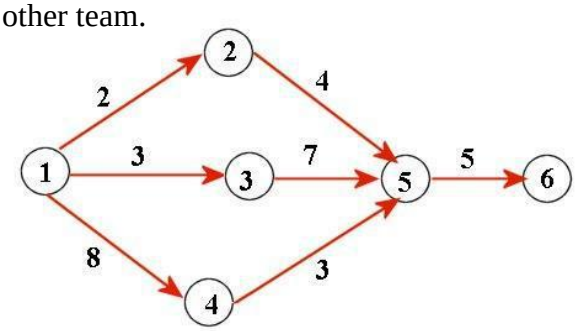
The biggest advance in project scheduling since the development of the Gantt chart in 1917 was made between1956-58. During this period, two new scheduling techniques were developed. These techniques are

(i) Program evaluation and review technique (PERT)

(ii) Critical path method (CPM)

Both are based on the use of a network/graphical model to depict the work tasks being scheduled. The popularity of network based scheduling can be attributed to its many benefits, especially its ease use. Other benefits include the following.

1. It provides a visual display of needed task and their temporal ordering, which makes it easy to see how tasks should be sequenced as shown below. This assists communication and co-operation among task teams because each team can see how its work affects other team.



2. It provides a relatively accurate estimate of the time required to complete the project at the proposed resource level.
3. It identified and highlights the tasks that are critical to keep the project on schedule.
4. It provides a method for evaluating the time-cost tradeoffs resulting from reallocating resources among tasks.
5. It provides a method for monitoring the project throughout its life cycle. As the project progresses, PERT/CPM easily identifies change in which tasks are critical and how the expected completion date is affected.
6. It provides a convenient method for incorporating uncertainty regarding task times into the schedule and it helps to evaluate the effect of this uncertainty on project completion time.

Difference between PERT and CPM

S.No.	PERT	CPM
1	PERT is a probabilistic model with uncertainty in activity duration. Activity duration is calculated from t_0, t_p and t_m.	CPM is a deterministic model with well known activity duration
2	It is an event oriented approach.	It is an activity oriented approach.
3	PERT terminology uses word	CPM terminology employs word like

	like network diagram, event and slack.	arrow diagram, nodes and float.
4	The use of dummy activity is required for representing the proper sequencing.	No dummy activity required.
5	PERT basically does not demarcate between critical and non-critical activities.	CPM marks the critical activities.
6	PERT is applied in projects where resources are always made available.	CPM is applied to projects where minimum overall cost is the prime importance.
7	PERT is suitable in Defence project and R&D where activity time can't be readily predicted.	Suitable for plant maintenance, civil construction projects etc. where activity duration is known.

Steps in using network techniques

1. Plan of project
   a. The project is analyzed by determining all the individual activities (sometimes called tasks/jobs/operation) that must be performed to complete it.
   b. A planned sequence of these activities are shown on a network (a graph where arrow and circles represent the relationship among project activities)
2. Schedule of project
   a. How long it will take to perform each activity is estimated.
   b. In order to locate the critical path, calculation is performed (the longest time chain of sequential activities which determines the duration of project). This step also provides other information that is useful in scheduling.
   c. The above information are used to develop a more economical and efficient schedule.
3. Project monitoring
   a. The plan and schedule started above are used to monitor the progress.

b. Throughout the execution of project, the schedule is revised and updated so that the schedule represents the current plan and status of progress.
c. PERT, Critical path, Most likely time estimates.

Resource leveling: There are two types of resource problem

(i) Resource smoothing
(ii) Resource levelling

(i) Resource smoothing: There may be a ceiling on the availability of resources in a particular period of time. For instance, only Rs 125 lakh per annum may be available to the project and if unutilized during the year, the remaining amount lapses. The resource analysis used for this type of case is called Resource smoothing.

(ii) Resource levelling: A resource may be required to be used in a uniform manner. For instance, in the present day labour situation one cannt have 100 labourers yesterday, 30 today and 80 tomorrow. Once a labour is hired, it is difficult to hire him. The rate of usage of labour has to be uniform. Resource analysis used for this category of problems is called Resource levelling.

LESSON – 10

CONTENTS

10.0 QUALITY MANAGEMENT

Quality Management: Quality circle may be defined as a small group of workers (5 to 10) who do the same work voluntarily meeting together regularly during their normal working time usually under the leadership of their own supervisor to identify, analyze and solve work related problems.

This group presents the solution to the management and wherever possible implement the solution themselves. The QC concept was first originated in Japan in 1960. The basic cycle of a quality circle starts from identification of problem.

Philosophical basis of QC

1. A belief that people will take pride and interest in their work if they get autonomy and take part in decision making.
2. It develops a sense of belongingness in the employees towards a particular organization.
3. A belief that each employee desires to participate in making the organization a better place.
4. It is a mean/method for the development of human resources through the process of training, work experience and participation in problem solving.
5. A willingness to allow people to volunteer their time and effort for improvement of performance of organization.
6. The importance of each member's role in meeting organizational goal.
7. QCs are small primary groups of employees/workers whose lower limit is 3 and upper limit is 12.

8. Membership is voluntary. The interested employees in some areas may come together to form a quality circle.
9. Each quality circle is led by area supervisor.
10. The members meet regularly every week/ as per agreeable schedule.
11. The QC members are specially trained in technique of analysis and problem solving in order to play their role efficiently.
12. The basic role of quality circle is to identify work related problems for improving quality and productivity.
13. QC enables the members to exercise their hidden talents, creative skills, etc.
14. It promotes the mutual development of their member through cooperative participation.
15. It gives job satisfaction because of identifying and solving challenging problems while performing the job.
16. It provides their member with opportunities for receiving public recognition from the company's management.
17. The members also receive recognition in the form of memento, certificate and privileges.
18. It also contributes to their self-esteem and self-confidence through acceptance of their recommendation by the management.

Objectives of QC

a. To improve the quality and productivity.
b. To reduce the cost of products/ services by waste reduction, effective utilization of resources eliminating error/ defects.
c. To utilize the hidden creative intelligence of the employees.
d. To identify and solve work related problems.
e. To motivate people for solving challenging tasks.
f. To improve communication within the organization.
g. To increase employee's loyalty and commitment to organizational goals.
h. To enrich human capability, confidence, morale, attitude and relationship.
i. To pay respect to humanity and create a happy bright workplace.
j. To satisfy the human needs of recognition and self development.

Kaizan: Kaizen means change (Kai) to become good (Zen). In other words, it means continuous improvement. In fact, continuous improvement is required in all activities of the organization such as:

- Productivity improvement
- New product development
- Labor management relation
- Total productive maintenance
- Just in time production & delivery system
- Customer orientation etc.

The various activities of an organization where continuous improvement is required is presented under the kaizen umbrells. This continuous improvement in all areas are taken through small step by step process. Because various behavioural, cultural and philosophical changes are better brought about through small step by step improvement than through radical changes.

10.1 WORK STUDY

Work Study: Work study is a technique which is employed to ensure the best possible use of men, machine, materials and energy in carrying out a specific activity. It deals with the techniques of method study and work measurement.

Motion study: It is defined as a systematic and critical study of existing method of doing a task with a view to evolve the most efficient and economic method of doing it. It is a method for setting up employee productivity standards in which:

- A complex job is broken down into small or simple steps.
- The sequence of movements taken by the employee in performing those steps is carefully observed to detect and eliminate wasteful motion.
- Precise time taken for each correct movement is measured.

From these measurements, production and delivery times and prices are computed and incentive schemes are devised. Generally it is appropriate only for repetitive tasks. Time and motion studies were pioneered by the US industrial engineer

Frederick Winslow Taylor (1856-1915) and developed by the husband and wife team of Frank Gilbreth (1868-1924) and Dr. Lillian Gilbreth (1878-1972).

Objectives of motion study: The objectives of motion study are:

- To improve the procedure of doing a work.
- To improve the workplace layout (ultimately plant layout).
- To minimize the human motion for minimum fatigue of operators.
- To maximize the utility of resources (men, m/c, materials).
- To improve the overall working environment.

Principles of motion economy

- Analysis of an operation when carried out in terms of individual motion of a worker is known as Motion analysis.
- The purpose of motion analysis is to design an improved method which would eliminate unnecessary motion and employs human effort more productively. In doing so, the Principle of motion economy is very much helpful.
- It consists of a set of rules designed by Gilbreth and later rearranged and amplified by others (Branes Lowry et al) to develop better methods.

i. It is classified into following 04 categories: Rules concerning human body, workplace layout and material handling, Tools and Equipment Design and time conservation.

ii. Rules concerning human body

a. Both hands should be used for productive work.
b. Both hands should start and finish their motion at the same time.
c. Except for the rest period, the two hands should not be idle at one time.
d. Motion of both the hands and arms are symmetrical, simultaneous and opposite to each other.
e. Motions should be simple and involve minimum number of limbs. (The purpose-shortest duration and minimum fatigue)
f. Motion should be smooth and continuous. There should not be sharp direction change and frequent stop.
g. It is desirable for a worker to employ momentum to assist him.

h. A worker may use mechanical aids to assist him to overcome muscular effort.

iii. Rules concerning workplace layout and material handling

a. There should be a definite, fixed and easy accessible location for materials and tools.
b. As far as possible, materials, tools and other mechanical devices should be kept close to work place.
c. Gravity should preferably be employed wherever feasible with a conveyor for transportation and delivering materials at the workplace between various workstations and departments.
d. An assembled and final product should preferably be dropped on a conveyor near the workplace so that gravity delivers the job at the required place.
e. Tools and materials should preferably be located in the order/sequence in which they will be required for use.
f. Good illumination is required for proper seeing, fast operating and reducing the accidents.
g. In order to impart rest to some of the limbs, an operator may sometimes sit or stand while working. This necessitates a relationship between his chair, height of table or workpiece.
h. In order to reduce fatigue, the sitting arrangement of the worker should be comfortable and adjustable.
i. All heavy parts should be lifted by mechanical devices.

iv. Rules concerning Tools and Equipment Design

a. Jigs, fixtures and foot operated devices should be employed to reduce the work load on hand.
b. Tools should be multipurpose and easy to handle.
c. Foot-operated switches and controls should be designed as far as possible to reduce the workload on the hands.
d. Tools and materials should be properly arranged and located near the workpiece.
e. Tools and materials should be located in the order of their use.
f. There should be maximum surface contact between the tool handle and hand. It helps proper application of hand force and minimizes fatigue.
g. Gravity should be used for delivery of materials and finished goods.

h. Where the work is supposed to be carried out by fingers, the load distribution on each finger should be as per normal capacity of finger.
i. A worker should have the flexibility to stand or sit comfortably while working.
j. A worker should be able to operate levers and handles without changing the body position.
k. The workplace should have proper ergonomics in terms of illumination, proper conditions of heat, cold and humidity, reduced dust and noise, etc.

v. Rules concerning time conservation

a. Even temporary ceasing of work by a man or m/c should not be encouraged.
b. Machine should not run idle as it leads to loss of production and power.
c. Two or more jobs should be done at the same time, or two or more operations should be carried out on a job simultaneously.
d. Number of motions involved in completing a job should be minimized.
e. The loading and unloading of the job and the cycle time should be synchronized in such a manner that one operator can be multi-functional or can simultaneously operate a number of machines.

Procedure in Motion Analysis: The steps in motion analysis are as follows:

a) Select: Select the work to be studied.
b) Record: Record all the relevant facts of the proposed work by direct observation.
c) Examine: Examine the facts critically in sequence, using special critical examination sheet.
d) Develop: Develop the best method i.e. the most practical, economic and effective method under prevailing circumstances using the principle of motion economy.
e) Install: install that method as standard practice.
f) Maintain: maintain that standard practice by regular routine check.

Recording: The recording may trace the movements of men, material or details of various processes. The principle is to use the simplest technique which will contain all relevant information needed for investigation.

Time study

- It was proposed by Frederick Taylor and later modified to include a performance rating (PR) adjustment.

- Once the method is established, the next objective is to set the standard time for the work. This aspect of work study is called Time study (or Work measurement).
- The main objectives of time study are:
  1) To determine the standard time for various operations which helps in fixing wage rates and incentives.
  2) To estimate the cost of product accurately.
  3) To predict accurately the duration for a particular work and customer is promised accordingly.
  4) To determine the number of machines an operator can run.
  5) To determine the optimum number of men and machine.
  6) To provide information for planning and scheduling.
  7) To balance the work of all workers working in a group.
  8) To compare the work efficiency of different workers/operators.

Work measurement techniques

1. Time study using stop watch.
2. Predetermined motion time system (PMTS).
3. Work sampling.
4. Analytical estimating.

The following table shows the application of each technique and unit of measurement.

Technique	Application	Unit of measurement
Time study using stop watch	Short cycle repetitive jobs	Centiminute (0.01 min)
PMTS	Manual operationsconfined to one work centre	TMU (I TMU = 0.006 min)
Work sampling	Long cycle jobs/ Heterogeneous operation	Minute
Analytical estimating	Short cycle non-repetitive job	Minute

Time study using stop watch is the most popular technique for determining standard time. The first task of the analyst is to divide the work/job into smaller work elements in such a way that the time for each element should not be less than 3 seconds because for such elements, recording time is difficult. The steps of time study are as follows:

Step 1: First select the job to be studied. Breakdown the work content of the job into smallest possible elements. Then, inform the worker and define the best method.

Step 2: Observe the time for appropriate number of cycles (such as 25 to 50).

Step 3: Determine the average cycle time (CT)

$$CT = \frac{\sum \text{Times}}{\text{No. of cycles}}$$

Step 4: Determine the normal time (NT)

NT = CT (PR)

Where, PR is the performance rating.

Step 5: Determine the standard time using the following formula.

$$ST = NT(AF) \text{ where } AF = \frac{1}{1 - \% \text{ Allowance}}$$

AF being the allowance factor.

Selection of job for Time Study: Time Study is conducted on a job

- which has not been previously time-studied.
- for which method change has taken place recently.
- for which worker(s) might have complained as having tight time standards.

Selection of Worker for Time Study: The worker on which time study should be conducted must

- have necessary skill for the job.
- have sufficient experience with the given method on the job (that is, he should have crossed the learning stage).
- be an ‘average' worker as regards the speed of working.
- be temperamentally suited to the study (those who can't work in normal fashion when watched, are not suitable for the study).
- have knowledge about the purpose of study.

Time Study Equipment: The following equipment is needed for time study work.

- Timing device
- Time study observation sheet
- Time study observation board
- Other equipment

Timing Device. The stop watch is the most widely used timing device used for time study, although electronic timer is also sometimes used. The two perform the same function with the difference that electronic timer can measure time to the second or third decimal of a second and can keep a large volume of time data in memory.

Time Study Observation Sheet. It is a printed form with spaces provided for noting down the necessary information about the operation being studied, like name of operation, drawing number, and name of the worker, name of time study person, and the date and place of study. Spaces are provided in the form for writing detailed description of the process (element-wise), recorded time or stop-watch readings for each element of the process, performance rating(s) of operator, and computation. Fig. shows a typical time study observation sheet.

OBSERVATION SHEET

SHEET 1 OF 1 SHEETS	DATE
OPERATION	OP.NO.
PART NAME	PART NO.
MACHINE NAME	MACH.NO.
OPERATOR'S NAME & NO.	MALE ☐ FEMALE ☐
EXPERIENCE ON JOB	MATERIAL
FOREMAN	DEPT.NO.

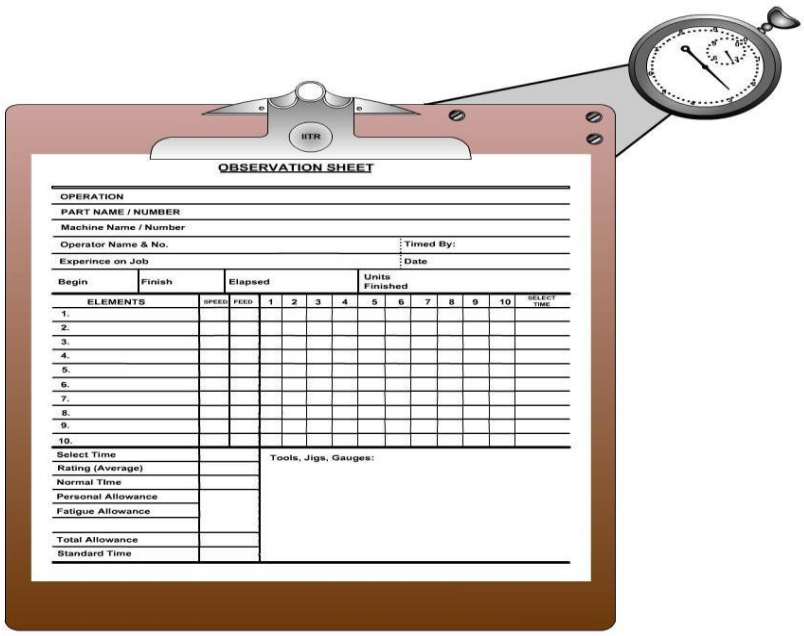
BEGIN	FINISH	ELAPSED	UNITS FINISHED	ACTUAL TIME PER 100	NO. MACHINES OPERATED

ELEMENTS	SPEED	FEED		1	2	3	4	5	6	7	8	9	10	SELECTED TIME
1.			T											
			R											
2.			T											
			R											
3.			T											
			R											
4.			T											
			R											
5.			T											
			R											
6.			T											
			R											
7.			T											
			R											
8.			T											
			R											
9.			T											
			R											
10. (1)			T											
			R											
11. (2)			T											
			R											
12. (3)			T											
			R											
13. (4)			T											
			R											
14. (5)			T											
			R											
15. (6)			T											
			R											
16. (7)			T											
			R											
17. (8)			T											
			R											
18.			T											
			R											

SELECTED TIME	RATING	NORMAL TIME	TOTAL ALLOWANCE	STANDARD TIME

SKETCH OF COMPONETS:	TOOLS.JIGS.GAUGES:
	TIMED BY:

Time Study Board. It is a light -weight board used for holding the observation sheet and stopwatch in position. It is of size slightly larger than that of observation sheet used. Generally, the watch is mounted at the center of the top edge or as shown in Figure near the upper right-hand corner of the board. The board has a clamp to hold the observation sheet. During the time study, the board is held against the body and the upper left arm by the time study person in such a way that the watch could be operated by the thumb/index finger of the left hand. Watch readings are recorded on the observation sheet by the right hand.



Other Equipment. This includes pencil, eraser, device like tachometer for checking the speed, etc.

Why Dividing Work into Short Elements is essential?

For the purpose of time study, the task is normally broken into short elements and each element is timed separately for the following reasons:

- To separate unproductive part of task from the productive one.
- To improve accuracy in rating. The worker may not work at the same speed throughout the cycle. He may perform some elements faster and some slower. Breaking of task into short elements permits rating of each element separately which is more realistic than just rating once for the complete cycle.
- To identify elements causing high fatigue. Breaking of task into short elements permits giving appropriate rest allowances to different elements.
- To have detailed job specifications. This helps in detection of any variation in the method that may occur after the time standard is established.
- To prepare standard data for repeatedly occurring elements.

The following guidelines should be kept in mind while dividing a task into elements.

a. The elements should be of as short duration as can be accurately timed.(This in turn, depends on the skill of the time study man, method of timing and recording, and many other factors. Generally, with the stop watch, elements of

duration less than 0.03 to 0.05 minute are difficult to time accurately. The elements should not normally be longer than 0.40 min.).

b. Manually performed elements should be separated from machine paced elements.(Time for machine paced elements can be determined by calculation). Machine elements are not rated against a normal. This rule also helps in recognition of delays.
c. Constant elements should be separated from variable elements.
d. The beginnings and endings of elements should be easily distinguishable. These should preferably be associated with some kind of sound.
e. Irregular elements, those not repeated in every cycle, should be separated from regular elements. For example, if the jig is cleaned off after every ten parts produced, "cleaning" is an irregular element, and its time should be spread over ten cycles.
f. Unnecessary motions and activities should be separated from those considered essential.
g. Foreign or accidental elements should be listed separately. Such elements are generally of non-repetitive type.

Number of cycles to be timed.: The following general principles govern the number of cycles to get the representative average cycle time.

a. Greater the accuracy desired in the results, larger should be the number of cycles observed.
b. The study should be continued through sufficient number of cycles so that occasional elements such as setting-up machine, cleaning of machine or sharpening of tool are observed for a good number of times.
c. Where more than one operator is doing the same job, short study (say 10 to 15 cycles) should be conducted on each of the several operators than one long study on a single operator.

It is important that enough cycles are timed so that reliable average is obtained.

Following techniques are used to determine the number of cycles to be timed.

(i) Use of Tables: On the consideration of the cost of obtaining the data and the desired accuracy in results, most companies have prepared their own tables for the use of time study, which indicate the number of cycles to be timed as a function of the cycle time and the frequency of occurrence of the job in the company.

(ii) Statistical methods: On the basis of the requirements of the particular situation involved, *accuracy* and *confidence level* are decided (An accuracy of a confidence level of 95% is considered reasonable in most cases). A preliminary study is conducted in which some (say *N)* cycles are timed. Standard deviation o of these *(N)* observations is calculated as

$$\sigma = \sqrt{\left[\frac{1}{N}(t-T)^2\right]} = \frac{1}{N}\sqrt{N(\sum t^2) - (\sum t^2)}$$

Where t = each watch reading

T = average of N watch reading

n = number of watch readings in the preliminary study.

Now, to find M.the number of cycles to time. the following statistical method can be used.

calculated standard error of mean ε from the equation

$$X.\varepsilon = A.T$$

Where A = accuracy desired

t = average of N watch reading

X = a factor corresponding to confidence level desired. Its values is 1 for 68%, 2 for 95%, and 3 for 99% confidence level.

Determine the required sample size M from the equation

$$\varepsilon = \frac{\sigma}{\sqrt{M}}$$

Performance Rating: It is a process of comparing the performance rate of a worker against standard performance. The standard performance is different for different jobs. Te rating factor is used to convert the observed time into normal time.

$$\text{Normal time} = \text{Observed time} \times \frac{\text{Performance level of worker}}{\text{Standard performance level}}$$

Allowances: Allowances are added to normal time in order to arrive at standard time. The various allowances are:

1. **Process allowance:** This is an allowance provided to compensate for enforced idleness during a process. This includes loss of time due to (i) no work (ii) power failure (iii) faculty material (iv) faculty tool or equipment.

2. **Personal and Rest allowance**: This is allowed to compensate for the time spent by worker in meeting the physical needs, for instance a periodic break in the production routine. The amount of personal time required by operator varies with the individual more than with the kind of work, though it is seen that workers need more personal time when the work is heavy and done under unfavorable conditions. The amount of this allowance can be determined by making all-day time study or work sampling. Mostly, a 5 % allowance for personal time (nearly 24 minutes in 8 hours) is considered appropriate.

Rest allowance is a relaxation allowance to a worker to overcome fatigue incurred during working. Excessive fatigue badly affects the performance of worker. This rest/relaxation may vary from 12% to 20% of normal time from light to heavy.

3. **Special Allowances**: These allowances are given under certain special circumstances. Some of these allowances and the conditions under which they are given are:

   Policy Allowance: Some companies, as a policy, give an allowance to provide a satisfactory level of earnings for a specified level of performance under exceptional circumstance. This may be allowed to new employees, handicap employees, workers on night shift, etc. The value of the allowance is typically decided by management.

   Small Lot Allowance: This allowance is given when the actual production period is too short to allow the worker to come out of the initial learning period. When an operator completes several small-lot jobs on different setups during the day, an allowance as high as 15 percent may be given to allow the operator to make normal earnings.

   Training Allowance: This allowance is provided when work is done by trainee to allow him to make reasonable earnings. It may be a sliding allowance, which progressively decreases to zero over certain length of time. If the effect of learning on the job is known, the rate of decrease of the training allowance can be set accordingly.

   Rework Allowance: This allowance is provided on certain operation when it is known that some percent of parts made are spoiled due to factors beyond the operator's control. The time in which these spoiled parts may be reworked is converted into allowance.

4. **Policy allowance:** It depends on the policy of an organization controlled by workers union.

Problem 1: In a welding shop, a direct time study was done on a welding operation. One inexperienced industrial engineer and one experienced industrial engineer conducted the study simultaneously. They agreed precisely on cycle time but their opinion on rating the worker differed. The experienced engineer rated the worker 100% and the other engineer rated the worker 120%. They used a 10% allowance.

Cycle time (in minutes)	Number of times observed
20	2
24	1
29	1
32	1

From the above statement,

(a) Determine the standard time using the experienced industrial engineer's worker rating.

(b) Find the standard time using the worker rating of inexperienced industrial engineer.

Solution:

(a)Rating of worker at 100% by the experienced industrial engineer Cycle time (CT) = (20×2+24×1+29×1+32×1)/5 = 25 min Normal time (NT) = CT×PR = 25×100% = 25 min

Standard time (ST) = NT/(1-%A) = 25/(1-0.10) = 27.78 min

(b) Rating of worker at 120% by the inexperienced industrial engineer Cycle time (CT) = (20×2+24×1+29×1+32×1)/5 = 25 min

Normal time (NT) = CT×PR = 25×120% = 30 min Standard time (ST) = NT/(1-%A) = 30/(1-0.10) = 33.33 min.