NATIONAL OPEN UNIVERSITY OF NIGERIA

SCHOOL OF BUSINESS AND HUMAN RESOURCE MANAGEMENT

COURSE CODE:ENT420

COURSE TITLE:PRODUCTION MANAGEMENT II

COURSE GUIDE

ENT420
PRODUCTION MANAGEMENT II

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Introduction

ENT420 – PRODUCTION MANAGEMENT II is a semester course work of three credit hours. It will be available to all students taking the B.Sc. programme in the School of Business and Human Resources Management. The course consists of 15 units and is the second sequence to ENT417 (Production Management I).

The course guide tells you what ENT420 is about, the material you will be using and how to make use of them. Other conformations include the self assessment exercises and tutor-marked assignment.

Course Content

The course content consists of principles of production and material management and also quality control management.

Course Aim

The aim of this course is to expose you to the principles and practices of production management. This will be achieved by considering:

- the principles and practice of production management
- the concept of material management and
- the concept of statistical quality control management

Course Objectives

After going through this course, you should be able to:

- explain the universality of the production function.
- identify the key principles, practices and techniques of production.
- explain the concept of quality control and material management.

Course Materials

- Course Guide
- Study Units
- Text Books
- Assignment Guide

Study Units

There are 15 units in all

Module 1 Concepts of Material Management

Unit 1 Material Management
Unit 2 Manufacturing Technology
Unit 3 Research Development and Design

Module 2 The Principles, Practices and Technique of Production

Unit 1 Quality and Total Quality Management
Unit 2 Location and Layout of Small Business
Unit 3 Stores and Stock Control
Unit 4 Production and Labour
Unit 5 Organisational Aspects of Production
Unit 6 Time Study
Unit 7 Statistical Quality Assurance
Unit 8 Activity Sampling and Control Charts

Module 3 Statistical Quality Control (Assurance)

Unit 1 Production Facility Layout
Unit 2 Technical Report Writing
Unit 3 Costing
Unit 3 Network Analysis, Main Content, Exercises, Conclusion, Summary and References

The Modules

The course is divided into three modules. The first module has 3 units the second module consists of 8 units and the third module consists of 4 units.

Module I treats the concepts of material management while Module II treats the principles, practices and technique of production and Module III treats statistical quality control (assurance) aspects.

Assignment

Each unit will consist of at least one assignment which you are expected to do.

Tutor-Marked Assignment

You are expected to apply what you have learnt in the contents of the study units to do the assignments and send them to your tutor for grading.

Final Examination and Grading

This will be done at the end of the course.

Summary

ENT420 (PRODUCTION MANAGEMENT II) will expose you to the principles and practices of production management. The course will expose you to the challenges of production in industries or related organisations.

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MODULE 1 CONCEPTS OF MATERIAL MANAGEMENT

UNIT 1 MATERIAL MANAGEMENT

CONTENTS

1.0 INTRODUCTION

This unit will take a cursory look at material management vis-à-vis concepts and scope, quantity and quality, time and price.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- explain the concepts and scope of material management
- state the condition for making decisions regarding quantity and quality
- explain the concept of time and price in relation to stock management.

3.0 MAIN CONTENT

3.1 Material Management

3.2 Concept and Scope of Material Management

According to Needle (1999) material management has become a function in the manufacturing industry, and has superseded the more traditional activities of purchasing and stock control. It aims to improve organisational effectiveness through the planning, coordination and control of all materials and in so doing coordinates the activities of purchasing, and stock control.

The main features of material management are:

- planning
- purchasing
- production and inventory control
- storage; and
- material handling and physical distribution

The main objectives of material management are:

- to optimise performance in meeting agreed customer service requirement
- to add to the profitability by minimising costs
- to make the best use of available resources

Needle (1999) is of the view that material management has two-fold importance:

- The interaction of the production functions with its environment. For instance, the prices of goods, which can be influenced by various environmental factors such as demand.

- Material management has significant impact on a firm's cost and hence profitability.

3.3 Decisions Regarding Quality, Quantity and Source

Sources, quality and quantity are key variables of purchasing. The decision concerning the source of a firm's raw material and component has an attendant effect on other variables such as time, price, quality and quantity. Management must take a decision on the source of supply of materials and component that will meet its needs in respect of quantity, quality and at an acceptable price.

Though a firm may choose to build a good relationship with a single supplier who can guarantee regular supply at the competitive market rate, it is however desirable, at least for a more regular supply of goods to look for as many sources as possible.

Varieties of sources will not only provide greater security but also positively affect the quality and the prices of the goods supplied.

The decisions regarding the quantity of goods to be purchased at any time depends on the function of cost, storage capacity and the nature of the production system. The inventory cost which embraces carrying costs, ordering cost and stock out cost, must be determined before a decision is taken. The applicable decision model is known as the Economic Order Quantity Model.

The quality of incoming raw materials must also be given adequate consideration. This is because the quality of the raw material is a determinate of the quality of the finished product.

3.4 Time and Price

Time and price are also key variables of purchasing. The timing is a function of the needs of the production system, storage capacity and price. A decision must be taken as to whether to buy now or wait until prices fall.

A difficult situation may arise where a certain commodity is price sensitive. Such a commodity may be subject to speculation and therefore increases the risk in decision-making.

A firm that chooses to wait may run out of business when its stock runs out before prices fall, whilst some companies could choose to engage in hedging, that is buying materials and stocking them at the current price for delivery at some future date.

SELF ASSESSMENT EXERCISE

Enumerate the reasons for holding raw material inventory.

4.0 CONCLUSION

Material management, being a function in manufacturing industries, must be given its due recognition in order to maximise cost and maximise profit.

5.0 SUMMARY

The prime objectives of material management is to optimise performance in meeting the need of customers while at the same time reducing cost and maximise profitability.

The main features of material management are:

- planning
- purchasing
- production and inventory control
- storage
- material handling and physical distribution etc.

ANSWER TO SELF ASSESSMENT EXERCISE

- Raw materials cannot be obtained from supplier exactly when needed.
- Larger quantities purchase can result to discount
- Larger shipments can result to reduced incoming freight cost and material handling cost.

6.0 TUTOR-MARKED ASSIGNMENT

State the features and objectives of material management.

7.0 REFERENCES/FURTHER READING

Needle, David (1999). *Business in Context*. London: Thomson Business Press.

Pitfield R. Ronald (1984). *Business Organisation*. London: M & E Books.

UNIT 2 MANUFACTURING TECHNOLOGY

CONTENTS

1.0 INTRODUCTION

The unit will take a look at production system with specific references to CNC, FMS and Robotics.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- explain the concept of numerical control
- identify the key features of Flexible Manufacturing System (FMS)
- explain the use of Robotics in manufacturing.

3.0 MAIN CONTENT

3.1 Manufacturing Technology

3.1.1 Numerical Control

Manufacturers today have taken advantage of development in the field of computer to enhance their production capabilities particularly in the area of product design and the operation and control of production system. Such machines are commonly referred to as Computerised Numerical Control (CNC).

According to Needle (1999), numerical control, occurs when machinery, tools and equipment come under the control of a digital computer. The CNC is an example of a computer aided manufacturing. Its major advantage is that it makes possible contour–controlled cutting operation without the machine requiring any form of reset.

3.1.2 Robotics

This is the integration of computers and industrial robots. The robot, which is controlled by a computer, is able to manipulate and perform certain human activities such as welding, painting and filling.

The robot can be compared to the human arm to which a variety of tools can be attached to perform a variety of jobs from metal work to painting. Many of such robots operate from a fixed position with the restricted movement defined by a computer program.

Today, robotics performs precision tasks of assembling electronic circuit boards. In addition, they are fast replacing human labour in repetitive, unhealthy and unpleasant tasks.

Despite the benefits derivable from the use of robots in manufacturing, the cost of producing a robot is quite considerable, hence robotics can only find good use in expensive labour economies, it is economical to use human labour.

3.1.3 Flexible Manufacturing

Flexible Manufacturing Systems (FMS) make use of elements of advanced manufacturing engineering to solve the problem of offering consumer choice and a quick response to market changes using minimum or working capital.

The components of an FMS are:

- equipment comprising, Numerical Control (NC) machinery, robots and machine tools.
- automatic transport system for moving tools and working pieces as well as parts and raw materials.
- a Computer-Controlled system with software for scheduling, tool selection, part selection, fault finding, machine breakdown detection etc. with FMS, a range of different model can be built in the same production line. An FMS of this nature would incorporate a multiple tool system, a CNC machine with the capability of performing a number of different machine tool operations.

Piore and Sabel (1984) identify the merits of the FMS as:

- Higher productivity would be achieved through the better utilisation of plant, materials and labour.

- A greater number of products variant would be possible in smaller batches offering the consumer greater choice and potential satisfaction.

- Reduced set-up time and consequently, shorter manufacturing lead time and a more flexible response to change.

- The need for fewer inventories at all stages of the production process, fewer parts, less work in process and less finished stock.

- Improved production and quality control.

Despite these merits, the use of FMS is still limited to a few big firms as a result of its attendant cost and the fact that returns in investment is only feasible on the long run. If one juxtaposed the above with the social implication of labour or job displacement then one may begin to rethink the idea of investing on FMS, CNC and Robotics.

SELF ASSESSMENT EXERCISE

What is Robotics?

4.0 CONCLUSION

CAD/CAM has come to stay as new and innovative technology in the manufacturing industries. Though the cost is high at the moment, extensive use will add to cost reduction.

5.0 SUMMARY

Despite the cost limitations, the computer is now extensively used in manufacturing industries. CAD/CAM or CIM are now key features of the production sector of our industries.

Robotics CNC and FMS now eliminate the need for people to do noisy, dirty and dangerous tasks though with a potential threat of job displacement.

ANSWER TO SELF ASSESSMENT EXERCISE

The word Robotics is generally used to describe the integration of the computer and industrial robots. Robotics is an example of Computer Aided Manufacturing (CAM).

The robots controlled by a computer are able to manipulate and perform certain human activities like welding, painting and filling.

The robots can be likened to a human arm to which a variety of tools can be attached to perform a variety jobs.

6.0 TUTOR-MARKED ASSIGNMENT

Enumerate the features and merits of the Flexible Manufacturing Systems (FMS).

7.0 REFERENCES/FURTHER READING

Piore, M and Sabel, C. (1984). The Second Industrial Divide: *Possibilities for Prosperity*. New York: Basics Books.

Needle, David (1999). *Business in Context.* London: Thomson Business Press.

UNIT 3 RESEARCH DEVELOPMENT AND DESIGN

CONTENTS

1.0 INTRODUCTION

This unit will take a cursory look at the concept of Research, Development and Design.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- differentiate between research and development
- identify the areas covered by a research policy
- explain the term “Design”.

3.0 MAIN CONTENT

3.1 Research, Development and Design

3.2 The Concept of Research and Research Policy

The Oxford English mini dictionary defined the word research as study and investigation to discover facts.

According to Pitfield (1984), industrial research is concerned with the acquisition of technical knowledge, particularly new products, processes, techniques, materials and sources of energy.

Research is broadly classified into two, namely:

- fundamental (or pure) research
- applied research

3.2.1 Fundamental Research

This is aimed at extending knowledge, with no apparent practical application. Since it is financially unproductive, industries may not undertake this type of research. A research of this nature may lead to a "spin off" that is a discovery which is peripheral to the main research objective but which produces a financial reward.

3.2.2 Applied Research

This is a direct investigation with a view to financial benefit.

The areas covered by a research policy include:

a. **responsibility** – establish a research department, specifying its scope and to whom it is answerable.

b. **areas of Research** – must be decided by management.

c. **cost/benefit** – expense on research may be unproductive and the actual reward on successful research may not be accurately determined.

d. **production feasibility** – A line of research may appear to be scientifically successful but the decision to convert the discovery to profitable is not taken by the researcher.

3.3 Development

This is the practical application of the results of research and is often the responsibility of the research team under the umbrella or research and development department. Once a discovery is tested in working conditions, those responsible must ensure that the discovery is capable of being manufactured at an economic cost and must have a potential market.

A research conducted by one firm can be adapted for use by another. Usually, development is fairly long-term. Adequate time is required to test the new product to see how it stands up to normal usage, which design faults appear with time and what the breakdown rate is. During the period, potential buyers use the product to discover latent faults.
Recently, this writer and other passers-by were offered free packs of fruit juice about to be introduced into the market. Each potential buyer

was requested to drink it, write comments on a pre-prepared form and drop the form at any of the pre-designated centres. This is referred to as user-testing.

It serves as feedback to the manufacturers and/or distributors.

3.4 Design

This is the final stage in the R & D process which translates development unto the final product for the consumer. This stage attempts to fuse certain elements which are referred to as the "design mix". According to Needle (1999), the "design mix" is effective operation, safety, easy maintenance, value for money and aesthetic consideration geared towards meeting the needs of the customers.

Design is a critical aspect of production and marketing processes. In the car manufacturing industries for instance, the marketability of the product depends largely on the design and styling as well as the inherent product qualities. In general, parity exists between product quality and product design and style.

According to Pitfield (1984), a product designer is concerned with the reconciliation of the ideal functional version and the version which will appeal to the buyer. He must make sure that reconciling these two ideals will not make the cost of the product prohibitive. Two aspects to be considered are:

- **Functional (or Technical) Design**

This is the case where customer's preference for appearance is not relevant.

- **Formal (or Aesthetic) Design**

Here, the customers are concerned more with the appearance rather than the structure and working of the product.

3.4.1 Design Errors

a. Commitment to a Design

Once decision is taken on the choice of design or design specification, it is usually difficult to make alteration. The implication of this is that any error in function or maladjustment of consumer pretences will mean that much time will be spent on modification and this will result in delays.

b. Evidence of Errors

This may be due to:

- consumer complaints of malfunction and maintenance cost.
- decline of sales (unattractive or too expensive).
- undue amount of scrap in production (bad design resulting in wasteful methods).

SELF ASSESSMENT EXERCISE

What are the key areas covered by a research policy?

4.0 CONCLUSION

The R & D unit is a key aspect of most organisations manufacturing and non-manufacturing concerns.

The department looks into the possibility of improving the organisation current status or opening new ground for future development.

5.0 SUMMARY

Industrial research is primarily concerned with the acquisition of technical knowledge, particularly new product, processes technique, materials and sources of energy.
Different types of research are identified. These are:

- pure research
- basic research
- industrial research

Development is the stage at which the outcome of research is translated into something tangible while the design stage is the final stage in the R&D process. It translates development into final products for the consumer.

ANSWER TO SELF ASSESSMENT EXERCISE

The key areas covered are:

- Responsibility
- Areas of research
- Cost/benefit
- Production feasibility

N.B: Brief explanation required.

6.0 TUTOR-MARKED ASSIGNMENT

What is the connection of "development" with "research"?

7.0 REFERENCES/FURTHER READING

Pitfield, R. Ronald (1984). *Business Organisation*. London: M & E Handbooks.

Needle, David (1999). *Business in Context.* London: Thomson Business Press.

MODULE 2 THE PRINCIPLES, PRACTICES AND TECHNIQUE OF PRODUCTION

UNIT 1 QUALITY AND TOTAL QUALITY MANAGEMENT

CONTENTS

1.0 INTRODUCTION

In this unit we are going to look at the concept of Quality and Total Quality Management.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- identify the costs associated with Quality
- explain the concept "Total Quality Management"
- list the criticisms against the concept TQM.

3.0 MAIN CONTENT

3.1 Quality and Total Quality Management

3.2 Quality and Its Associated Cost

The Oxford English mini dictionary defines quality as a degree of excellence, a characteristic distinctive attribute of a person or thing.

Generally, the notion of quality is inherent in every organisation. Mission statements of most organisation have the phrase "quality service" or "quality products" boldly inscribed.

According to Needle (1999), the traditional view of a quality product is that it conforms to specifications.

Today, however, quality is seen in the perspective of the customer vis-à-vis value for money, reputation, appearance, safety, ease of use, customer support and behaviour of staff with whom the customer has contact.

Quality has costs associated with it. These are:

a. **Failure Costs:** This refers to those costs incurred when goods are found to be faulty. The cost includes those incurred by the company in scrap or replacement.

b. **Appraisal Costs:** Are those costs involved in the installation and operation of a quality control system. It includes the time taken to complete paper work systems and the employment of staff with specific responsibility for quality control.

c. **Prevention Costs:** This entails the establishment of mechanisms which build quality procedures in all operations.

3.3 Total Quality Management (TQM)

TQM emerged from the work in statistical quality control at the Western Electric Hawthorne plant in the 1930s.

It is a strategic approach to quality which embraces the entire organisation. The main features of TQM are:

- it is a top-down management philosophy that focuses on the needs of customer.
- it comprises a quality plan which offers a structured, disciplined approach to quality.
- it is culturally based, with involvement as a core philosophy.
- by focusing on the costs of poor quality, it saves money.

- it encompasses the notion of continuous improvement and as such, it is essentially long-term.

3.3 Criticism of TQM

TQM has been subjected to a series of criticism principal among them are:

- that the importance of TQM has been over-emphasised to the detriment of the effects of technology, market dominance and the influence of the state and the control of critical raw materials.
- that TQM may be feasible in some organisations but greatly limited in some others.
- that the assumption that total quality is relatively easy to come by is misguided.
- that the feature of excellence may not be directly linked to companies that adopt the concept of TQM alone.
- that a strong commitment to TQM may lead to resistance to change.
- that the not-so excellent companies may exhibit the same attributes.
- that it is difficult to prove a relationship between TQM and company performance.

SELF ASSESSMENT EXERCISE

What is Quality and what are its associated costs?

4.0 CONCLUSION

TQM is a holistic approach to Quality Management. Top management determines the quality priorities and establishes the systems for its administration.

5.0 SUMMARY

TQM is a strategic approach to quality which affects the entire organisation. It incorporates certain essential features and has its associated cost.

ANSWER TO SELF ASSESSMENT EXERCISE

The word Quality refers to a distinctive attributes of a person or thing. The traditional view of a quality product is that it meets or conforms to specifications. The view is now replaced by a notion that views quality from the perspective of the customer.
The costs associated with quality are:

- failure costs
- appraisal costs
- prevention costs.

6.0 TUTOR-MARKED ASSIGNMENT

What are the essential features of TQM? Briefly explain each.

7.0 REFERENCES/FURTHER READING

Needle, David (1999). *Business in Context.* London: Thomson Business Press.

UNIT 2 LOCATION AND LAYOUT OF SMALL BUSINESS

CONTENTS

1.0 INTRODUCTION

This unit will take a critical look at the location and layout of small businesses. Special attention will be paid to the study of guidelines for a good layout and the choice of location.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- state the guidelines for a good layout
- state the factors responsible for the choice of small business location
- explain the concept of production planning and control

3.0 MAIN CONTENT

3.1 Location and Layout of Small Business

3.2 Guidelines for a Good Layout

The layout and physical structure of a business plays a key role in the profitable running of a business. An entrepreneur needs to consider his financial position before deciding whether to build, rent or lease the physical structure for the business.

Once a decision is made, the entrepreneur must plan the layout of his business, bearing in mind the under listed guidelines:

a. Identification of Buying Habits

A business planner must identify his/her customer and their behaviours. The knowledge of the customers' behaviour will enable the planner to arrange his product in such a way that it attracts impulsive buying. That is customers are attracted to buy what they never plan to buy.

b. Conspicuous Display of Merchandise

When products are conspicuously displayed, customers are easily attracted to the products they want to buy. They can make comparisons of price ranges, styles, designs or alternative products.

c. Good Arrangement of Merchandise

Goods which are most often purchased by customers should be arranged in close proximity on the shelves or counters. Such arrangement saves customers the headache of having to move round the store to look for products in the same group. For instance, bread, butter, milk, sugar, tea or beverage should not be far from each other.

d. Grouping of Activities

Related activities should be grouped together.

Selling activities should be separated from non-selling activities. In such a case, the selling activities should be located in front while other activities are located at the back.

e. Separation of Activities in Terms of Class or Gender

The class or gender of customers should be considered when allocating store space. The layout should appeal to the class or gender of the customers you are dealing with.

f. Interior and Exterior Surrounding

The surrounding should be well ventilated, good lighting, friendly and warm. Repeated patronage depends largely on this.

3.3 Planning and Controlling of Product Work

According to Pitfield (1984), planning and controlling of production work entails:

- deciding the process to be adopted
- schedule the sequence of operations
- establish time-schedule
- ensure material availability
- check progress continuously
- determine the cause of any deviation
- resolve the difficulty

- adjust material delivery and advise the sales department of any change in completion date due to deviation

Effective planning and control is very essential for the successful achievement of the set goals. It could be done on a day-to-day basis, week-to-week or month-to-month basis. Production planning may entail:

- plans for current and immediate future operation
- intermediate-range plans to provide for the required capacity of workers, raw materials and equipment.
- long-range plans to provide for capacity, locations, changing product and service mix, and exploitation of new product and services.

A key problem usually associated with planning and controlling of production activities in Nigeria is the non-availability of accurate and reliable data for making forecasting and taking necessary decision and actions.

3.4 Factors Responsible for the Choice of Small Business Location

The factors responsible for the choice of small business location are:

a. Proximity to Desired Market

This is desirable where products are easily damaged or where transport is expensive.

b. Proximity to the Source of Raw Materials

This is desirable for bulky and perishable raw materials. The cost of transportation is reduced.

c. Proximity to Labour Supply

Businesses should be located where there would be adequate supply of needed labour.

d. Availability of Transportation

This is essential for timely supply of raw materials and easy evaluation of finished products.

e. Consideration of Adequate and Cost of Power

Business should be located where there is cheap and adequate supply of power, fuel, water and electricity.

f. Good Climate

The climate should be suitable for both humans and production process.

g. Proximity to Businesses of the Same Class or Group

This is necessary so that the business can benefit from the services of other businesses around.

h. Consideration for Future Expansion

Allowance should be made for future expansion

i. Consideration of Communal Hostility and Friendliness

Business should not render goods and service that affect the sensibility of their immediate communities and in a situation where the local community is restive due to government neglects.

j. Political Situation and Reasonableness of Local Regulations

This is an important factor that could make or mar small business concerns. Stability of polity and sanity in local regulations help business to grow in a conducive atmosphere.

SELF ASSESSMENT EXERCISE

State the guidelines for a good layout.

4.0 CONCLUSION

The location and layout of a business play a role in the profitable management of business. Management takes cognisance of these roles and exploits them to advantage.

5.0 SUMMARY

A good layout is desirable because it facilitates the attainment of the desired goals and further minimisation of result expected. Other factors to be considered include the factor responsible for the choice of small business location and guidelines for a good layout.

ANSWER TO SELF ASSESSMENT EXERCISE

The guidelines are:

- Identification of buying habit
- Conspicuous display of merchandise
- Full utilisation of available space
- Grouping of activities
- Separation of activities in terms of class or gender
- Interior surroundings

6.0 TUTOR-MARKED ASSIGNMENT

Enumerate the factors responsible for the choice of business location.

7.0 REFERENCES/FURTHER READING

Bambe, R.A., & Ayeni, J.M & *Small Business Management.*

Amajo, B.T. (2000). *The Nigerian Approach*. Ilorin: SMC Printing and Publishing Company.

UNIT 3 STORES AND STOCK CONTROL

CONTENTS

1.0 INTRODUCTION

This unit will introduce you to the concept, scope and objectives of stores control and stock management.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- state the objectives of Stores Control
- state the methods of Stock-Taking
- state the necessity, for Stock-Taking.

3.0 MAIN CONTENT

3.1 Stores and Stock Control

3.2 Concept, Scope and Objectives of Stores Control

In manufacturing industries, it is imperative that the responsible departments ensure that the right amount and quality of materials are available as required. It entrails the purchase and storage of goods and it operates in relation to financial control.

This concept is generally referred to as Inventory Management.

Inventory Management may be regarded as reservoir management because it results in the stocking of right amount of materials for future use.

There are three types of inventory:

- finished goods inventory
- in-process inventory
- raw material inventory.

The need to hold stock is based on the variability of both supply and demand for finished goods, the stock thus held, act as a batter and remove the need for placing emergency special order for meeting customers order for out-of-stock items.

Stores and stock control is therefore hanged on the following objectives:

- to ensure availability of goods when required
- to reduce storage costs as much as possible
- to preserve goods
- to maintain accurate records and provide management data.

3.2.1 Finished Goods Inventory

This refers to products hold as reservoir to meet customers' demand.

The reasons for holding finished goods inventory are:

- production of products at the time demanded by customers can be uneconomical.
- in some conditions, backlogging of customers' orders may not be permitted.
- stabilisation of production output that may result in lower production cost is permitted
- products are displayed to customers.

3.2.2 In-Process Inventory

This is also referred to as Work-in-Process Inventory. It is the reservoir of materials held for work at various stages of completion.
The reasons for holding in-process inventories are:

- successive processing steps can be separated thereby permitting flexibility in planning each step.
- production rates of processing steps are unequal in various operations.

- producing and transporting in large batches may reduce materials handling and production cost.

3.2.3 Raw Materials Inventory

Raw materials are held in warehouses for future demand by production. Inventory of raw material are kept for the following reasons:

- raw materials cannot be obtained from suppliers exactly when needed for production schedules
- large quantities can result to reduced incoming freight costs and materials handling cost.
- larger shipment can result to reduced incoming freight costs and materials handling costs.

3.3 Stock Levels

It is imperative that stores officer maintain appropriate and optimum level of stock. Too high a level will result in an undue amount of capital being tied up in stock; increased in storage cost of rent, lighting, insurance etc, greater risk of determinant damage etc. On the other hand, too low a stock will endanger supplies needed immediately for production and may involve having to purchase immediately, irrespective of price.

Factors to be considered when deciding on stock level are:

a. minimum, maximum and reorder levels

This is the fixing of stock below which it would be dangerous to go; fixing the maximum above which it would be uneconomical to store; and deciding the level at which goods must be recorded.

b. lead time

This is the allowance to be made for delivery. For instance re-ordering is expected to take place before the minimum level is reached because of the time taken for delivery.

c. deterioration risks

Where these are high, stock should be kept as it is safe and economic.

d. storage costs

This is the cost of keeping or carrying excessive quantities of material in inventory for an extended.

e. risk of obsolescence

Tools may become outdated if kept for so long

f. price movement

It may be economic to stockpile if prices are expected to rise.

g. economic amount

Storage cost can be partly offset by the economies of buying large quantities.

3.4 Necessity for Stock-Taking

Stock taking is done for the following reasons:

- to value for the purposes of the account
- to determine insurance cover
- to calculate the cost of carrying stock
- to detect pilferage and deterioration

3.5 Methods of Stock Taking

a. Annual

Every item is counted so that a valuation appears in the annual accounts. The valuation will be certified by the firm's external auditor.

The main element of this system is that much labour is used over a period of concentrated activity.

b. Perpetual Inventory

This means a continuous process of checking and counting. In this case permanent staff of unchanging size may check every section of the store so that the whole is checked over a period. This is normally carried out more than once a year. Physical count is reconciled with the records; the latter is adjusted where there exist some discrepancies. The main merits of perpetual inventories are:

- disruption of the stores is minimised

- no extra staff is required for short period, as regular staff members are being used.
- the stock-takers have time to check thoroughly.
- discrepancies are identified early.
- slow-moving stocks can be identified.

3.6 Pricing of Stock

It is necessary to value material issued from stores for production for the purpose of costing. Since materials in constant use may be purchased at different prices, it is therefore difficult to decide the cost of any item as part of the production cost.

Method of costing includes:

a. Cost Price

This is used only where purchase is specific to a particular job and can be directly related to it.

b. Average Price

This is obtained by adding the total of the variety of prices and dividing by the number of prices.

c. Weighted Average Price

This gives a more realistic figure by allowing for the quantities purchased at different prices. The total cost of stock are added together and divided by the total unit purchased.

$$\text{Weighted average} = \frac{\text{Total costs}}{\text{Total units}}$$

d. First-In, First-Out Price (FIFO)

Here, the materials received first are issued first and charged out on this basis.

e. Last-In, First-Out Price (LIFO)

The price paid for the last purchase is taken as the issue price.

SELF ASSESSMENT EXERCISE

State and explain the methods of valuing stock.

4.0 CONCLUSION

Since stocks are valued for the purpose of the account, it is important that appropriate method be used and proper inventory taken and level of stock to be kept decided by taking some critical factors into consideration.

5.0 SUMMARY

All manufacturing concerns need to keep or maintain optimum level appropriate to different sorts of stocks.

The level of stock to be carried will depend on some factors such as minimum, maximum and reorder levels lead-time, declaration risk obsolescence, price movement etc.

Inventory may be taken annually or perpetually. The material issued from store for production must be valued for the purpose of costing.

ANSWER TO SELF ASSESSMENT EXERCISE

The methods of valuing stock are:

- Cost
- Average
- Weighted average
- FiFO
- LiFO

N.B: Brief explanation required

6.0 TUTOR-MARKED ASSIGNMENT

1. What are the objectives of stores control?
2. Why is it necessary to set the optimum level of stock?

7.0 REFERENCES/FURTHER READING

Pitfield, R. Ronald (1984). *Business Organisation*. M & E Books Ltd.

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UNIT 4 PRODUCTION AND LABOUR

CONTENTS

1.0 INTRODUCTION

This unit introduces us to the concept of Production and Labour. Specific attention will be paid to the influence of scientific management organisation of production as well as the role of payment system as an incentive and as a production control device.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- identify the influence of scientific management on organisation of production
- state the problem associated with De-skilling
- examine the role played by payment system as an incentive and as a production control device.

3.0 MAIN CONTENT

3.1 Production and Labour

3.2 Scientific Management and De-Skilling

Frederick W. Taylor is commonly referred to as the Father of Scientific Management. His work was focused on the following ideas:

- improvement of working tools
- analysis and innovation of work methods

- enforced standardisation of work methods.
- enforced cooperation.

The Scientific Management School represents an attempt to solve the problem of management incompetence – which was largely hinged on problem of control due to:

- size and complexity of organisation
- growth of trade union and union activities

The work process entails:

- the design of task and work measurement
- careful selection and training of the workforce
- target setting and the design of payment systems.

According to Needle (1994), application and/or misapplication of Taylor ideas result in:

- extensive division of labour
- work simplification and tight managerial control

Extensive division of labour means that work becomes fragmented, the machine becomes more important than man and there is the shift of control from skilled workers to management whose actions and decisions have been programmed or standardised.

Taylor's work was criticised for the following reasons:

- managerial control
- reduction of man to the level of a machine
- crude economic approach etc

Despite the criticism, Taylor's work and/or scientific management offer(s) solutions which are acceptable to many, hence its widespread application.

3.3 Solution to the Problem of De-skilling

To counter the negative impact of De-skilling on the individual worker, some theories and techniques were suggested.

The efforts include:

- human relations management
- job rotation
- job enlargement

- job enrichment
- autonomous work groups,
- participation schemes

These efforts may entail redesigning the work to give workers more responsibility, more control, greater sense of achievement and ultimately more satisfaction.

3.4 Payment System

Pay is a key factor in the interaction of labour and production. Pay is the motive and the incentive for individual worker to participate in the production process. It is used by management as a control device. Since labour is an input to the production system, it therefore represents a significant cost to the firm and hence management invariably attempts to control it.

A pay system should be designed in such a way that it acts as an effective means of motivation and control. A typical example of a pay system is payment by results. It takes many forms but all generally subscribe to payment for increased output subject to quality, wastage and machine utilisation. This form of incentive schemes is most relevant under the following situations:

- in highly competitive markets, where output or quick response to customers' demands may be vital in establishing a competitive advantage.
- where the workplace is large and some form of impersonal control needed.
- in firms with relatively high labour cost, where some control can be exerted by varying the work flow;
- where workers can control the pace of work either as individual or members of a group.
- where opportunities for personal involvement with work are lacking and pay is the only motivator.

Though this method is highly criticised it is recognised by those who seek to change the culture of the organisation to gain greater commitment from the workforce.

SELF ASSESSMENT EXERCISE

Identify some key solutions to the problems of De-skilling and briefly explain two of them.

4.0 CONCLUSION

As an organisation grows, the need to control and motivate the workforce by means of a well designed incentive scheme becomes imperative.

5.0 SUMMARY

Fredrick Taylor's work on scientific management represents an attempt to solve the problem of management incompetence which is largely due to the growing size and complexity of the organisation and the growth of trade unions.

Despite the widespread acceptance, the work was criticised because shift of control and the preference of machine instead of skilled work could lead to De-skilling the workers.

The solutions to the problem of de-skilling were largely hinged on creating an enabling environment where workers would feel satisfied with their work.

ANSWER TO SELF ASSESSMENT EXERCISE

a. Solutions to the problems of De-skilling are identified as:

- human relations management
- job rotation
- job enrichment
- autonomous work groups
- participation schemes.

b. Job Enrichment

This is focused on the content of jobs. It redesigns tasks with a view at giving workers more control, more responsibility, greater sense of achievement and ultimately more satisfaction.

The manager thus freed from labour control can devote time to deal with the problems of the immediate environment.

6.0 TUTOR-MARKED ASSIGNMENT

What is payment by results, and under what circumstances is it most relevant?

7.0 REFERENCES/FURTHER READING

Paul, W. and Robertson, K. (1970). *Job Enrichment and Employee Motivation.* London: Gower Press.

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UNIT 5 ORGANISATIONAL ASPECTS OF PRODUCTION

CONTENTS

1.0 INTRODUCTION

This unit will take cursory look at the interaction between production function and organisation elements.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- state the effect of organisation size on production function
- state the influence of organisational goals and culture on production
- state the relationship between organisation structure and the production system.

3.0 MAIN CONTENT

3.1 Organisational Aspects of Production

3.2 Production and Organisation Size

The size of a firm can be expressed in term of the number of employees and the capital invested. This in turn has a close relationship with the production function.

Mass production of goods, such as vehicle-manufacturing, is usually carried out by large firms with large numbers of employees and huge capital investment.

According to Needle (1994), the size of a firm will affect production in some ways.

- Sheer size and complexity of production process will influence the size of the workforce and capital employed
- The size of the firm and its output required will determine the precise nature of the production system, particularly the production technology.

The relationship between organisation size and the production system is best shown in the way the production process is organised and its impact on the organisation structure

3.3 Production and Organisation Structure

An organisation structure is a grouping of activities and people to achieve the goals of the organisation. Considerable variation is possible in the type of structure employed and the influences at work include technology, size, the nature of the environment, management strategy, and the behaviour of interest groups, the firm's history and the wider culture factors. (Needle, 1994).

A structure is concerned with:

- grouping activities in such a way that it achieves the goals of the dominant coalition
- organisation of work around roles
- grouping of roles to form teams or departments
- allocation of power and authority to the various role
- job descriptions, mechanism for coordination and control, and the management information systems.

The factors which influence structure are:

a. Technology

Research has shown that technology determines:

- the extent of management hierarchy,
- the proportion of management to other employees,
- the proportion of direct to indirect labour,
- the number of subordinates controlled by any one manager

b. Size

As businesses increase in size, the problems of coordination and control emerge. The solution to the problems will require a change structure and the application of the principle of delegation. According to Child (1984), the size and complexity of organisation's operations significantly impart on its structure and consequently the production systems and technology.

3.4 Organisational Goals and Culture

The goals of an organisation are commonly perceived as financial and marketing goals. This perhaps explain why most firms are dominated by accounting and the need for quick returns on investment, with little regard for or interest in, developing the technical know-how essential for new product development and improving the manufacturing system.

Modern trends however support the need to change organisational culture by redrawing the traditional organisational chart to show production at the centre and all other functional areas being subsidiary to and either fitting into or out of production (Needle, 1994).

For this change to take place, a corporate culture which stresses technical competence as its key criterion and endeavours to recruit and develop technically qualified managers must be embraced.

SELF ASSESSMENT EXERCISE

In what ways does organisational size affect production?

4.0 CONCLUSION

Organisation size, structure culture and goals affect production system and production technology

5.0 SUMMARY

This unit took a cursory look at the impact of organisational size, structure, culture and goals on production. Studies have shown that size, technology, culture and goals determine the structure of an organisation. Conversely, organisational structure influences the production system.

ANSWER TO SELF ASSESSMENT EXERCISE

Organisation size affects production in the following ways:

- size and complexity of the production process will influence the size of the workforce and capital
- production system and technology is determined by the size and output requirement of the firm.

6.0 TUTOR-MARKED ASSIGNMENT

What is organisational structure?

7.0 REFERENCES/FURTHER READING

Needle, David (1994). *Business in Context.* London: Thomson Business Press.

Child, J. (1984). Organisations: *A Guide to Problems and Practices*, (2nd ed.). London: Harper and Row.

UNIT 6 TIME STUDY

CONTENTS

1.0 INTRODUCTION

This unit will treat the concept of Time vis-à-vis Unoccupied Time and Machine Interference.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- explain the concept of time
- explain the meaning of unoccupied time
- determine the value of unoccupied time.

3.0 MAIN CONTENT

3.1 Time Study

Time is an inelastic raw material. It is totally perishable and cannot be stored. Other resources can be substituted but there are no substitutes for time. “Time is money” and “it waits for no body”.

Time study will enable us to know how we can qualitatively manage or control time in course of performing a task.

The elements of a time study are the observed time rating, and basic time.

Rating and observed times are recorded in a time study. Rating is a subjective assessment of the speed and effort applied by the operator.

On the British Standard Scale, 100 rating is known as standard rating whilst observed time is directly observed using a stopwatch.

Rating will adjust the observed time to the anticipated time for a defined level of performance.

This gives us the basic time. That is the time taken by an operator to complete an element of work. Calculated allowances are usually added to basic time to accommodate the in measurable time which represent loss of machine efficiency.

Contingency allowances must be added to take account of work which must be done but which is not part of the job.

Other allowances to be added are:

- **rest (or fatigue)** allowance to compensate the worker for national loss of energy.

- **interference allowance** to compensate for efficiency loss in situation of multi-loading due to random machine stop pages.

The sum of the basic time and allowances are given as Standard Time.

$$\text{Basic Time} = \frac{\text{Observed Rating x Observed Time}}{\text{Standard Rating}}$$

$$= BT = \frac{OR \times OT}{SR}$$

Where BT is Basic Time
OR is Observed Rating
OT is Observed Time
SR is Standard Rating

The constituents of Time are:

- irreducible work content,
- work added by defective design,
- work added by defective method,
- time added as a result of bad management,
- time added due to poor performance of the operator.

3.2 Unoccupied Time (UT)

Unoccupied time is the period during which an operator suffers enforced idleness, either where the job is machine – controlled or in team work where some workers are dependent on others:

Unoccupied Time is – unproductive time.

It is expressed as

UT = Overall Time for carrying out a task − Standard Time for carrying out the task

A practical example of unoccupied time can be seen in the case of two or more operators working together on a job. Where this is the case, there are usually imbalances between the amount of work each worker is required to do and, as a result, one worker waits for the other, and hence an unoccupied period of time. The worker with the most work to do is the lead worker, though this is not necessary the case.

Let us consider two hypothetical workers assigned to fill and seal a bag of salt. Suppose that it takes worker A three minutes to fill a bag, and it takes worker B one minute to seal the bag. If they are required to produce ten bags of salt, worker B will wait for three minutes for worker A to fill the bag, two minutes before filling the second bag and so on.

The total time worker B had to wait for worker A to fill the bag with salt is known as the Unoccupied Time.

3.3 Value of Machine Interference

Machine Interference is the queuing of machines or processes as a result of a worker being responsible for attending to more than one machine. Putting a worker in charge of a number of machines (say, 100ms) is economically desirable but these machines are subject to unpredictable stoppages which will call for his attention before restarting.

Machine Interference refers to the way these stoppages occur. Since stoppage can occur in two or more machines at the same time and the worker can only attend to one at a time, then one or two of the machine will be temporarily idle, thus affecting the total output.

3.3.1 Calculation of the Number of Machine per Operative

Machine per Operative is given as: $\frac{\text{Cycle Time}}{\text{Total Work}}$

Outside Work/Outside Cycle Time is the work done by an operative when the machine is stopped.

Cycle Time = Machine Running Time (MRT) + Outside Work (OW)

Total Work = Outside Work (OW) + Inside Work (IW)
= OW + IW

So that Machine per Operative is given as: $\frac{\text{MRT + OW}}{\text{OW + IW}}$

The effect of Machine Interference is to increase the cycle time so that the Cycle Time becomes = MRT + Interference + OW

The number of Machines Per Operative now becomes:
MRT + Interference + OW.

In this case, the Interference will be to overload the operator, which will eventually lead to increased Machine Interference.

3.3.2 Calculation of Machine Interference

Machine Interference can be measured using various techniques such as production study, activity sampling systematic sampling etc.

It can also be calculated by using empirical equation scales like the one adopted by weight written as:

$$I = 50 \left[\sqrt{(1 + x - N)^2 + 2N - (1 + x - N)} \right]$$

Where I = Interference as a percentage of Outside Works,
X = Ratio of MRT to Outside Work, and
N = Actual Allocation of Machines.

SELF ASSESSMENT EXERCISE

What do you understand by Unoccupied Time?

4.0 CONCLUSION

Time study enables managers to know how to qualitatively manage time in the course of performing a task.

5.0 SUMMARY

Time is an inelastic raw material which must be qualitatively controlled in order to minimise cost. Time study will enable us to reduce unoccupied time and machine interference.

Time study could be done over a long period as in production study or short period as in check study.

ANSWER TO SELF ASSESSMENT EXERCISE

Unoccupied Time is the period during which an operator suffers enforced idleness, either where the job is machine-controlled, or in team work where some workers are dependent on others.

It is expressed as UT = OT – ST

Where UT ➔ Unoccupied Time
OT ➔ Overall Time for carrying out a task
ST ➔ Standard Time for carrying out the task

6.0 TUTOR-MARKED ASSIGNMENT

What is Time Study?

7.0 REFERENCES/FURTHER READING

Duncan, A.J. (1965). *Quality Control and Industrial Statistics*.Irwin: McGraw-Hill Inc.

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Booth, J.E. (not stated). *Textile Mathematics*. Vol. I and Vol. II.

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UNIT 7 STATISTICAL QUALITY CONTROL

CONTENTS

1.0 INTRODUCTION

This unit will consider the concept and scope of quality control.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- state the objectives of Quality Control
- identify the causes of Variation
- explain the term Acceptance Sampling.

3.0 MAIN CONTENT

3.1 Statistical Quality Control

3.2 Concept and Scope of Quality Control

Quality can be regarded as any activity directly or indirectly concerned with the maintenance of product effectiveness level. These include:

- manufacturing methods
- improvement by inspection methods

Improved manufacturing techniques and better machinery will improve the quality, however it is outside the areas satisfaction are concerned with. Conversely improvement by inspection method is commonly referred to as statistical quality control.

Statistical quality control is the collection of information concerning the quality of the manufactured product and the use of the information to make decision about the quality level.

This decision is usually one of two types:

- That the product quality does or does not meet some specification. This is called Acceptance Sampling.

- That the product quality level is or is not as constant as the process is capable of. Thus called Process Control. Control charts are good examples.

Since the decision procedure will be based upon a statistical analysis of the information obtained from a sample, the size and frequency of the sample must also be specified. This method is called sampling and decision procedure.

The object of this type of quality control is to replace a negative approach of inspecting or testing every item produced and thus discarding the defective item by a positive approach in which a departure from an acceptable quality level is defeated because an excessive number of defective items has been produced. Any form of quality control based on sampling must accept the fact that a certain fraction of the item produced may be defective.

The object of a quality control scheme is to ensure that a specified fraction of defective production is not exceeded. This measure of uncertainty caused by sampling is due to the fact that the procedure involves significant test.

3.3 Causes of Variation

No two parts of products are exactly the same. There is usually some degree of variations. There are two general causes of variation in a process, these are:

- chance variation
- assignable variation

Chance Variation

This is random in nature. It cannot be completely eliminated unless there is a major change in the equipment or material used in the process. Chance Variation could occur as a result of:

- internal machine friction,
- slight variation in material or process condition,
- atmospheric conditions, and

- vibration transmitted to machine from an external source, for instance a passing forklift.

Assignable Variation

This is not random. It can be eliminated or reduced by identifying the problem and the cause.

Examples of assignable variation are:

- a dull drill may drill too large a hole in a piece of metal
- replacing or restraining an operator
- a roll of steel to be used in the process may not have the correct tensile strength etc

Variations are to be considered for the following reasons:

- it will change the shape, dispersion and central tendency of the distribution of the product characteristics being measured.
- assignable variation is usually correctable, whereas chance variation usually cannot be corrected or stabilized economically

3.4 Acceptance Sampling

The basic situation is that a sample is taken from a batch of material (incoming) by using a statistical sampling plan, in this case a sample of units randomly selected from a lot *N units* (the population). This is referred to as acceptance sampling. The number of defects in the sample is determined by inspection. This number is compared with a predetermined called the critical number or the acceptance number designated as *C*.

If the number of defects in the sample of size, *r*, is less than or equal to *C*, the lot is accepted, otherwise, the lot is rejected. This means that acceptance sampling is a decision-making process. The decision is either to accept or to reject, while the situation is either the product is good or bad.

Where a lot contains more defects than it should, but it is accepted, the risk taken is called Consumer's Risk. In like manner, if the lost is within the agreed-upon limits but is rejected during the sample inspection; the risk borne is called the Producer's Risk.
An Operating Characteristic Curve (OC) is used to evaluate a sampling plan and to determine whether it is fair to both the producer and the consumer.

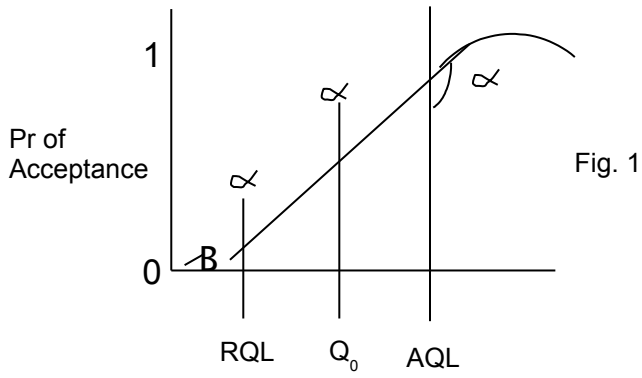

Fig. 1

The sampling decision is obtained by detailing an Acceptable Quality Level (AQL) and the risk α of the quality being rejected together with the Rejection Quality Level (RQL) and the risk α of the quality been acceptable.

Similarly, as shown in Figure II, the probability (pr) of acceptance is 1 and the decision procedure is

$$\theta > \theta_0 = 1 \text{ Accept, while}$$
$$\theta < \theta_0 = 0 \text{ Reject}$$

SELF ASSESSMENT EXERCISE

Explain the following:

(1) Manufacturers' risk
(2) Customers' risk

4.0 CONCLUSION

Quality control refers to any activities that are directly or indirectly concerned with the maintenance of product quality level, such as:

- manufacturing method
- improvement by inspection method

5.0 SUMMARY

The prime object of a quality control scheme is to ensure that a specified fraction of defective is not exceeded. The measure of uncertainty caused by sampling is due to the fact that the decision procedure involves significant test.

Causes of variation are:

(a) chance Variation.
(b) assignable Variation.

ANSWER TO SELF ASSESSMENT EXERCISE

1. Manufacturer's Risks

If P_1 is the proportion of defective products in the batch, the Pr of acceptance must be at least $(1 - \alpha)$, that is the risk of rejection is at most

2. Customer's Risks

If P_2 is the proportion of defective products in the batch, then the Pr of acceptance must be at most β that is Pr of rejection is at least $(1 - \beta)$.

N.B: P_1 N< P_2. Otherwise the situation is not feasible. Thus, Pr of accepting the batch is:

For (a) Manufacturer

$$\sum_{r=0}^{C} \frac{(nP_1)}{r!} e^{-(nP_1)} \geq 1 - \propto$$

For (b) Customer

$$\sum_{r=0}^{C} \frac{(nP_2)^2}{r!} e^{-(nP_2)} < \beta$$

6.0 TUTOR-MARKED ASSIGNMENT

What is acceptance sampling?

7.0 REFERENCES/FURTHER READING

Mason, Robert D.; Lind, Douglas A. and Williams G. Marshal (1999). *Statistical Techniques in Business and Economics*. Boston: Irwin McGraw-Hill Inc.

Duncan, A.J. (1965). *Quality Control and Industrial Statistics*. Boston: Irwin McGraw Hill Inc.

UNIT 8 ACTIVITY SAMPLING AND CONTROL CHARTS

CONTENTS

1.0 INTRODUCTION

In this unit, we shall answer activity sampling and control charts vis-a-vis the type, construct and interpretation.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- state the purpose and types of control charts
- explain the concept of activity sampling
- construct and interpret diagnostic charts.

3.0 MAIN CONTENT

3.1 Purpose and Types of Quality Control Charts

Control charts are used to identify when assignable causes of variation or changes have entered the process. It can be compared to the scoreboard of a football game. Fans, coaches and players can look at the scoreboard to know which team is winning and the playtime remaining. In like manner, workers, group leaders, quality control engineers, production supervisors and management use it to identify whether the production of the part or service is “in control” or “out of control”. If the production is out of control, the chart will not fix the situation but rather the person responsible will take necessary action to return production to “in control”

There are two types of control charts:

a. **Variable Control Charts:** Portrays measurement such as the time, it takes an operator to respond to our "out of control" signal in the production line. It requires the interval or the ratio scale of measurement using the central limit thereon, control charts for variables can be developed and the following relationships established:

(i) Grand Mean = $(\overline{\overline{X}})$

$$= \frac{\sum \text{of the mean of the subgroup}}{\text{Number of sample mean}} \quad \text{is}$$

$$\overline{\overline{X}} = \frac{\sum \overline{X}}{K}$$

(ii) Standard Error of the mean ($s_{\overline{X}}$)

$$= \frac{s}{\sqrt{n}}$$

Where $\overline{\overline{X}}$ = Grand Mean
$s_{\overline{X}}$ = Standard Error of the sample Mean
$\overline{X}$ = Sample Mean
K = Number of sample Mean

With these relationships, limits can be set up around the sample mean to show how much variation can be expected for a given sample size. The expected limits are called the UPPER CONTROL LIMIT (UCL) and the LOWER CONTROL LIMIT (LCL). So that control limit for the mean is given as

UCL = $\overline{\overline{X}} + 3\,{}^{s}/_{n}$
LCL = $\overline{\overline{X}} - 3\,{}^{s}/_{n}$

Since it can be shown that

$$3\frac{S}{\sqrt{n}} = A2\overline{R}$$

Then, UCL = $\overline{\overline{X}} + A2\overline{R}$
LCL = $\overline{\overline{X}} - A_2\overline{R}$

Where A_2 is a constant used in computing the upper and lower control limits.

R = Average range or mean of the ranges of the sample
x = The mean of the sample Mean

b. Attribute Control Chart: This classifies a product or service as either acceptable or unacceptable. It is based on the nominal scale of measurement.

3.2 Range Chart

This shows the variation in the sample ranges. If the points representing the ranges fall between the upper and the lower limits, then the operation is in control and 99.7% of the sample will fall within the limits. Otherwise, the assignable cause affected the operation and adjustment to the process is required. For small samples, the lower limit is often zero.

Thus, a control chart for ranges is given as

$UCL = D_4\overline{R}$

$LCL = D_3\overline{R}$

Where D4 and D4 can be obtained from a table of control charts.

3.3 Diagnostic Charts

These are techniques used to investigate quality problems. The common ones are:

- Pareto Charts
- Fishbone Diagram.

a. Pareto Charts or Analysis

This is a technique for tallying the number and type of defects that happen within a product or service. It was named after Vilfredo Pareto, who noted that most of the "activity" in a process is caused by relatively few of the "factors". This concept is often referred to as the 80-20 rule, that is 80% of activity is caused by 20% of the factors.

According to him, by concentrating on 20% of the factors, managers can attack 80% of the problem. To develop a Pareto Chart, first tally the type of defects, and then rank the defects in terms of frequency of occurrence from the largest to the smallest.

Thereafter, produce a vertical bar chart, with the height of the bars corresponding to the frequency of each defect.

b. Fishbone Diagram

The fishbone diagram is a cause and effect diagram. It is so called because of the need to emphasise the relationship between an effect and a set of possible causes that produce the particular effect. It helps to organise ideas and to identify relationship, it also helps to determine the factors that re the process. The effect, usually a particular problem or a goal is shown on the right hand side of the diagram, whilst the causes are listed on the left-hand side of the diagram. The usual approach is to consider four problem areas: material, equipment, method and personnel. The problems or the effect is the head of the fish.

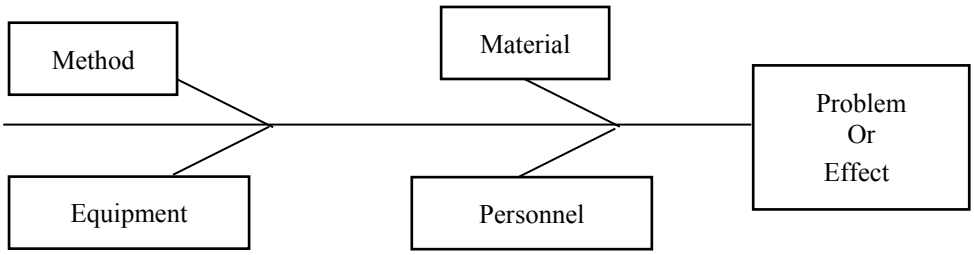

Fig II – *Fishbone Diagram*

3.4 Activity Sampling

A technique in which a number of successive observations is made over a period of time of one or a group of machines, processes or workers.

Each observation records what is happening at that instant and the percentage of observation recorded for a particularly activity or delay in a measure of the percentage of time during which that activity or delay occurs.
Activity sampling can be determined using:

(a) Relative Error Formula

$$N = \frac{4P(100 - P)}{L^2}$$

(b) Absolute Error Formula

$$SP = 196\frac{\sqrt{P(1-P)}}{N}$$

Or

$$SP = 2\sqrt{\frac{P\,(1-P)}{N}}$$

Where SP = Standard Error of a percentage activity or delay
S = Desired Accuracy expressed as a decimal
P = % occurrence of activity being measured
Obtained by a preliminary study
N = Number of random observation (i.e. sample size).

SELF ASSESSMENT EXERCISE

What are control charts? Give examples.

4.0 CONCLUSION

Having gone through this topic, you are now able to construct and interpret control charts and discuss activity sampling

5.0 SUMMARY

Control charts can be classified into Variable Control Charts and Attribute Control Charts. Other charts are Fishbone Diagram and Pareto Charts which are commonly called diagnostic charts.

A production activity may be "in control" or "out of control". A control chart assists management to identify when the situation is in control or out of control so that necessary action can be taken.

ANSWER TO SELF ASSESSMENT EXERCISE

Control charts are used to identify when assignable causes of variation or changes that have entered the process. Management uses it to identify when the production of a part or service is "in control" so that necessary actions can be taken.

6.0 TUTOR-MARKED ASSIGNMENT

Describe the differences between an Attribute Control Chart and a Variable Control Chart.

7.0 REFERENCES/FURTHER READING

Mason Robert D.; Lind, Douglas A. and Marshal, William G. (1999). *Statistical Techniques in Business and Economics*. Boston: Irwin McGraw-Hill Inc.

Duncan, A.J. (1965). *Quality Control and Industrial Statistics*. Boston: Irwin McGraw-Hill Inc.

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MODULE 3 STATISTICAL QUALITY CONTROL (ASSURANCE)

UNIT 1 FACILITY PRODUCTION LAYOUT

CONTENTS

1.0 INTRODUCTION

This unit will take a cursory look at facility layout with specific reference to the principles, types of facility layout and economic justification for each layout.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- state the principles of production facility layout
- state the different types of layout
- state the economic justification of layouts over each other.

3.0 MAIN CONTENT

3.1 Principles of Production Facility Layout

The principles of facility layout are:

1. General Integration

This entails the integration of various machines, materials and non-material resource and other support services under to create a conducive production environment.

2. Minimisation of Distance of Movement

This takes account of the volume of work to be done. The facility is arranged in such a way that materials moves minimum distance between operations.

3. Flow Principle

This involves progress movement of materials from one operation or process toward completion. It can be in straight line, zigzag or circular.

4. Full Space Utilisation

Economy is achieved by full space utilisation both horizontally and vertically. The height, width and length are also considered.

5. Satisfaction and Safety

A good layout should provide job satisfaction and safety.

6. Flexibility

Layout should be flexible and adaptive to change.

3.2 Types of Facility Layout

Facility layout can be categorised into:

(a) service facility layout and
(b) manufacturing facility layout

a. Service Facility Layout

These can be categorised into:

- those that are designed around the customer recurring services
- those that are designed around the technological process of physical, material and operating efficiency.
- those involved in manufacturing and warehousing where technology is applied in inventing arrangement.

b. Manufacturing Facilities Layout

These are:

- fine or flow or continuous process
- batch or intermittent production
- jobbing or unit production
- cellular manufacturing or group technology

Line Production

This is also referred to as product of series of machines or manual operation to carry out series of activities or operations. It is usually designed for a single product or a batch of product of car assembly.

Batch Production System

This is also referred to as process or functional layout. It consists of the same kind of machines grouped together. The sequences of process are most time, not the same and may require new set-up before processing.

Jobbing Unit Production

Here, facilities are more available when needed. It is not a permanent arrangement.

Group Technology

This is a production technique whereby families of components are manufactured in machine groups. It classifies individual components into families based on similarities such as form, size, material and degree of precision.

The main benefits of Group Technology are:

- reduction in set-up time and cost
- reduction of work in progress
- reduction of through-put time
- reduction in handling
- more job satisfaction
- less scrap

- material standardisation
- improved production methods
- flexibility of the system to accept more components.

3.3 Comparative Economic Justification of Layouts over Each Other

a. Set-Up Time

i. The total set-up time for flow of production is low. Machine/tools are only charged when they are worn out.

ii. The set-up time for batch system is high. Batch system is ideal for multi-product firm.

b. Routing

i. In a flow system, products move sequentially from one operation to another while in batch system, routing card are required.

c. Production Specification

In a flow system, many of the operations are remembered by heart this reducing the production time, whilst in the batch system, the operator may have to refer to the drawing and other specifications, leading to increased processing time.

d. Work-In-Progress

In a batch system, the components arrive at random whereas in a flow system arrival is assured provided the previous machine is kept running and passing the job at regular rates.

e. Continuity of Flow

The flow system comes to a stand still when there is a break down whilst the batch system simply switch to another machine on the group.

f. Through-Put Time

Through-put time is shorter in flow production then batch production system.

SELF ASSESSMENT EXERCISE

State the criteria for the economic justification of facilities component.

4.0 CONCLUSION

A production system may be more economical in one environment than another. It is therefore important some criteria be used in determining which system to be adopted.

5.0 SUMMARY

The choice of a facility layout is determined by certain criteria and principles, the criteria are:

- set-up time
- routing
- production specification
- work in progress
- continuity of flow and
- through put time,

While the principles are:

- general integration
- minimisation of distance of movement
- flow principle
- full space utilisation
- satisfaction and safety, and
- flexibility.

ANSWER TO SELF ASSESSMENT EXERCISE

- Set-up time
- Routing
- Production Specification
- Work-In-Progress
- Continuity of flow
- Through-put time

6.0 TUTOR-MARKED ASSIGNMENT

State and explain the principles of production facilities layout.

7.0 REFERENCES/FURTHER READING

Pitfield, R. Ronald (1984). *Business Organisation.* London: M&E Handbooks Ltd.

Asiegbu, B.C. (1998). *Operation Management.* (Unpublished Course Material)

Needle, David (1994). *Business in Context.* (Irwin).Thomson Business Press.

UNIT 2 TECHNICAL REPORT WRITING

CONTENTS

1.0 INTRODUCTION

This unit will take a look at the nature and elements of a technical report, the layout and the features of a good report.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- state the elements of a technical report
- enumerate the features of a good report
- write a good technical report.

3.0 MAIN CONTENT

3.1 Nature and Elements of a Technical Report

Reports are faithful account of some activity in which the writer participated. It is meant for a specific audience, either those who took part in the activity or another person or body (Akere, 1990).

Gholden (1964) defined report as an oral or written presentation that communicates information to a specific reader in a completely unbiased manner and in the form most usable by the reader for the purpose of solving a specific problem.

A report could be formal or informal. Our concern here is the formal report which is widely used by government agencies, managements and administrative personnel in industries as well as in various branches of science. Some basic questions that readily come to mind are:

- where are reports used?
- when are reports used?
- why do we need reports?
- how do we deliver reports?

The answer to the first question has already been provided. The "when" can be monthly, periodic, annual etc.

The "why" spells out the primary functions of report which are:

- to present the solution to a problem,
- to provide a basis of action for contingencies
- to disseminate new and useful information

The "how" "on the other hand refers to the mode of presentation or delivery of report which will be suitable to the reader.

A report is broadly divided into parts:

- the materials
- the organisation
- the expression

Reports consist of physical homogenous parts which are commonly referred to as the elements. The elements are used in formal and large report but industrial reports which are shorter have only the following as mandatory elements.

- introduction
- the body
- terminal section

All others are optional.

According to Glidden (1964), elements used in large/formal reports are:

- cover
- frontispiece
- inside title page
- copyright notice
- preface
- acknowledgement
- table of contents
- list of tables and illustrations

- symbols and notations
- introduction
- body
- terminal section
- appendix
- bibliography
- index

The introduction part will consist of:

- subject
- authorisation
- purpose
- background
- limitation
- sources of information
- brief conclusion
- plan of presentation

The Terminal Section is expected to agree with the Introduction and no new material should be introduced at this point.

3.2 The Effective Report

Communication is effective if the receiver understands the message sent to ensure that the reader understand the report, the right choice of language must be used. Language for report writing includes:

1. **Verbal: -** Makes use of words and follows the rules of grammar.

2. **Mathematical:** Figures and symbols are substituted for words; formal logic is used as the basis for precise rule of calculation.

3. **Chemical:** Use of symbols and figures.

4. **Graphical:** For instance:

- engineering drawing
- artistic delineation
- photographs
- tables etc.

An effective report is a good report presented or written by a good reporter. The features of a good report are:

- it provides the solution to a specific and limited problem
- it is tailor-made for a specific reader
- it is not a discussion
- it is completely objectives
- it is verifiable
- it shows the reader by the data presented rather than opinionating statement.
- it is written in formal and impressive language
- it uses concrete words
- it follows a prescribed reporting form
- it combines expository, writing with descriptive and narrative
- it contains new and useful information.

A good reporter must:

- make sure his facts are complete and verifiable
- question the use and spelling of unfamiliar words
- check up on what he is not sure of
- have a wide knowledge of sources of information
- be objective
- be up-to-date
- ensure that the result solves the problem rather talks about it.
- has a good sense of values to sources of information.
- clearly state conclusion
- understand the problem
- prepare effective outlines for both investigation and order of presentation.

In addition to the above, a good reporter must:

- use scientific methods in solving report problems
- understand his or her reader and place him or her in a paramount position.
- have a working knowledge of reporting language

3.3 Forms of Report

Forms of report are determined by the nature and types of report.
Report may be classified as:

- work report
- routine report
- investigation report
- special report
- police report

- eye witness report
- technical/scientific report

Some of the above reports are presented in pre-determined formats.

Forms or layout of report could assume any of the following formats:

- short forms or letter form
- long or detailed report
- chronological order (i.e. order of occurrence or order of importance).

The production super intended is required to submit a daily or weekly report of work done. This is largely routine and is presented in pre-determined format.

SELF ASSESSMENT EXERCISE

What are the features of a good reporter?

4.0 CONCLUSION

Government agencies, management and administrative personnel in industries as well as in branches of science and other areas of human endeavour use reports to identify or solve problems.

5.0 SUMMARY

Reports are used in every facet of human endeavour to identify or solve problems. Report writing requires certain skills and understanding. A good report is produced by a good reporter.

ANSWER TO SELF ASSESSMENT EXERCISE

- Must have the skeptical attitude of sympathetic doubt
- Has a creative imagination based upon wide experience
- Completely understands the nature and function of a report
- Has developed skill in analyses, classification and definition
- Uses scientific method in solving report problem
- Understands his reader
- Has a working knowledge of reporting language.

6.0 TUTOR-MARKED ASSIGNMENT

What is a report?

7.0 REFERENCES/FURTHER READING

Glidden, A. K. (1964). *Reports, Technical Writings and Specifications.* McGraw-Hill Inc.

Akere, Funso *et.al* (1990). *English across Discipline.* Lagos: Pumark Nig. Ltd.

UNIT 3 COSTING

CONTENTS

1.0 INTRODUCTION

This unit will introduce us to costing aspect of management accounting. Our primary focus shall be the element of costing, methods of costing and costing behaviour.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- state the elements of cost
- state the methods of cost
- explain cost behaviour.

3.0 MAIN CONTENT

3.1 Costing

The main elements of cost are materials, labour and services (or overheads).

Cost may be seen as past cost, the cost already incurred or future cost that is yet to be incurred. The elements of cost are categorised according to whether the cost items are incurred directly in relation to the product or in an indirect way.

Direct cost comprises direct materials, direct labour and direct expenses. Direct materials are materials used in the manufacture of the product

while direct labour refers to wages paid to production workers for work directly related to production or salaries directly linked to saleable services. Expenses directly incurred for the production or provision of a service is called direct expenses.

Conversely, indirect materials are not directly related to production of cleaning material. Similarly, indirect labour refers to wages which cannot be directly linked to production while indirect expenses are expenses with general relevance but not directly related to production.

3.1.1 Materials

Organisations' expenditure on materials is a large proportion of total cost. Relevant aspect of material control are purchasing receipt, storage and accounting function.

The Accountants are concerned with the management of the investment in materials and stocks through inventory control procedure and the problems involved in pricing issues of material to production.

The pricing systems are:

a. **FIFO (First In, First Out)** – Issues are priced at the price of the oldest batch in stock.

b. **LILO (Last in, Last Out)** – Issues are priced at the most recent batch until a new batch is received.

c. **Average Price** – This is a perpetual weighted average system where the issue price is calculated after each receipt taking into accounts both qualities and money value.

d. **Standard Price** – Predetermined price based on consideration of all factors which are expected to affect the price.

3.1.2 Labour Cost

Payment systems for production workers are essentially of two types.

- Those where straight time rates are paid and wages are not related to production level.
- Those where payment is related directly or indirectly to production levels.

Labour costs have some variable characteristic which are rarely linear.

3.1.3 Service Cost Centres

This is also referred to as overheads. Overheads are usually aggregated by the processes of classification, allocation and appointment and are then spread over the units produced.

N.B: Direct Material + Direct Labour + Direct Expenses = Prime Cost
Prime Cost + Overheads = Total Cost

a. Job Costing

This is aimed at establishing the profit or loss on each completed job and to provide a valuation of uncompleted job.

The job cost card will consist of

(i) Direct Labour – of piece work earning
(ii) Direct Material Costs of special purchases, bill of material and stores issues.

b. Batch Costing

This is used where a quantity of identical articles are produced together as a batch.

When a batch is completed, the total batch cost would be divided by the number of good articles provided so as to provide the average cost per article.

c. Contract Costing

This is used for works which are site based, of relatively long duration and undertaken to the customers' special requirement.

The main feature of contract is the provision for progress payment based on the activities certificate of work satisfactorily completed. The amount paid in the certified value as a percentage retention which is released when the contract is fully completed.

d. Process Costing

This is used for products which follow a series of sequential frequently automatic process, e.g. food processing.
It entails the averaging of the total costs of each process over the total throughput of that process and charging the cost of output of one process as the raw material input to the next process.

3.3 Cost Behaviour

Planning and decision making as cost, sales and other factors. Ability to predict cost and sales is therefore a fundamental aspect of management accounting.

Cost can be classified on fixed and variable.

A fixed cost is the one which within certain output limit tends to be unaffected by variation in the level of activity.
Variable cost is one which tends to vary in direct proportion to variations in the level of activity.

According to Lucey (1983), classifying cost is difficult because variable costs are not always linear and fixed costs do change. This means some costs are semi-fixed or semi-variable.

Cost assumes different patterns. Some are linear, curvi-linear or stepped at different activity range which are likely to be less accurate hence the need for linear approximation of curvi-linear function.

A curvi-linear variable cost, where each extra unit of output causes a less than proportionate increase in cost is called convex function. In this case, we have economy of scale while the concave function is one where diminishing returns operate. That is extra unit of output causes a more than proportionate increase in cost. A curvi-linear function is usually parabola and assumes the form $f = bx + cx^2 + dx^2 – px^{n.}$ To forecast future cost, the following approaches are used:

- Extra quotation based on historical data using statistical technique.
- Accounts classification
- Industrial engineering approach

When making cost and revenue forecast, the rate of inflation should be taken into consideration.

SELF ASSESSMENT EXERCISE

Explain the industrial engineering classifications method of cost forecasting.

4.0 CONCLUSION

Costing is a vital aspect of management accounting. It is key information required for planning and decision making.

5.0 SUMMARY

The key to providing vital information for planning and decision making in the ability to predict costs, sales and other factor.

Cost is fixed or variable, direct or indirect. The elements of cost are material, labour and overheads.

The most of costing are:

- job costing
- batch costing
- contract costing
- process costing

Cost can be forecast by using:

- the account classification method
- historical data
- industrial engineering approach.

ANSWER TO SELF ASSESSMENT EXERCISE

This method is used where there are no previous records of the launching of a completely new product or where conditions have changed substantially. It uses a detailed, elemental approach to establish the required level of inputs materials, labour, facilities, capital equipment for a particular level of output.

The input is then converted into money costs. The main features of the engineering approach are:

- it is lengthy
- it is expensive
- it can be accurate
- it is ideal for estimating production costs where there are clear, physical relationships between input and output
- it uses work study and production engineering techniques to establish what the cost should be.

6.0 TUTOR-MARKED ASSIGNMENT

State and explain the elements of costing?

7.0 REFERENCES/FURTHER READING

Lucey, T. (1983). *Management Accounting.* Hampshire: D.P. Publications.

Pitfield, R. Ronald (1984). *Business Organisation*. London: M& E, Handbooks.

UNIT 4 NETWORK ANALYSIS

CONTENTS

1.0 INTRODUCTION

This unit will take a look at network analysis as an important technique in planning and control.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- state and explain basic network terminology
- state the rules for constituting networks
- solve problem involving network.

3.0 MAIN CONTENT

3.1 Basic Network Terminology

Network Analysis is a term used to identify or refer to techniques which have been developed as an aid to project planning and control.

The techniques show the interrelationship of the various tasks or activities which make up the critical parts of a project. It provides planning and control information on the time, cost and resource aspect of the project.

Examples of such techniques are:

- Critical Path Analysis (CPA)
- Critical Path Scheduling (CPS)
- Programme Evaluation and Review Techniques (PERT)

Common terms used in network analysis are:

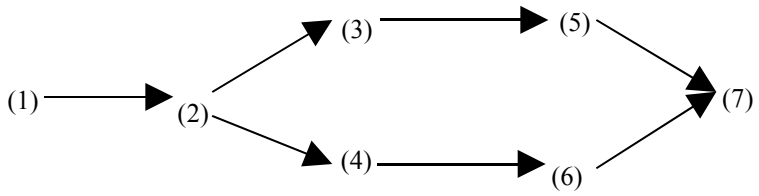
a. **Activity:** The tack or job which takes time and resources. It is represented by a solid arrow →

The head of the arrow indicates where the job ends and the tail where it begins. It points from left to right.

b. **Event:** A point in time and it indicates the start and the finish of an activity or group of activities. It is represented by a Ωrcle or node.

c. **Dummy Activity:** An activity which does not consume time or resources. It shows the dependence between activities so as to fulfill the procedures specified on the project. They are represented by a dotted arrow. - - - →

d. **Network:** A combination of activities, dummy activities and events on the sequence determined by the procedures given on the activity sequence.



3.2 Rules for Drawing Networks

The rules for constructing networks are:

- a complete network should have only one point of entry ¯ a START event ¯ and only one exit – FINISH event
- every activity must have one preceding or Tail Event and one succeeding or Head Event.
- no activity can start until its Tail Event is reached.
- an event is not complete until all activities leading to it are complete.
- loops or series of activities which lead back to the same event are not allowed.
- all activities must be tied to the network.
- danglers are not to be used.

The conventions to be observed when constructing networks are:

- networks proceed from left to right
- networks are not drawn to scale
- arrows need not be drawn in the horizontal plane unless it cannot be indicated by an arrow.
- events or nodes should be progressively numbered from left to right.

3.3 Network Calculation

Once a network is drawn, it is necessary to insert the activity duration time. The time estimate can be:

1. **Single Estimates: -** For each activity based in judgment, technical calculation or on records of similar, completed activities.

2. **Multiple Estimates: -** For each activity. These are:

- Optimistic (O)
- Most Likely (ML)
- Pessimistic (P).

A combination of the estimate gives the Expected Time.

$$\text{Expected Time} = \frac{0 + 4ML + P}{6}$$

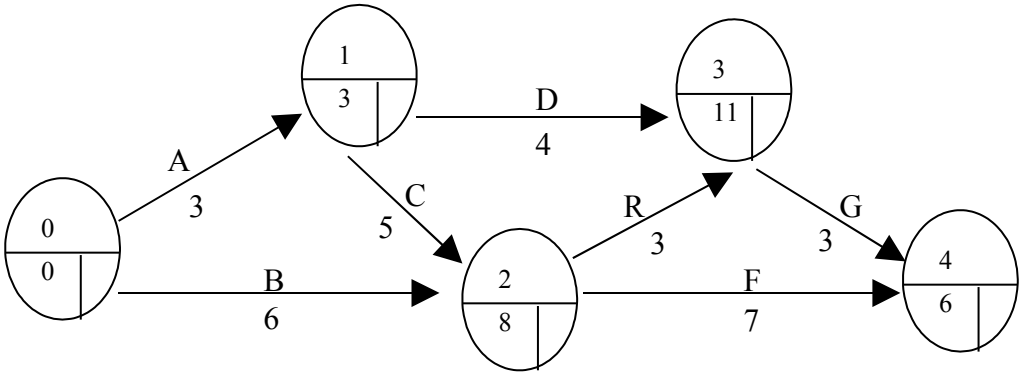
When carrying out basic time analysis, it is first necessary to calculate the project duration which the Critical Path.

The Critical Path (CP) of a project is the chain of activities with the longest total time. It is the shortest time in which the project as a whole can be completed. An activity on the Critical Path is said to be critical and must not be delayed, otherwise the task will be completed in their estimated time.
The Critical Path can be determined by using two sets of calculation, viz:

- forward pass
- backward pass

The Forward Pass Calculates the Earliest Start Time (EST) for each activity and this determines the duration of the project. It is earliest time at which a succeeding activity can start.
EST of head event obtained by adding onto the EST of the tail event the linking activity starting from Event O, Time O.

Where two routes arrive at an event, the LONGEST route time is taken. *Consider the network below:*



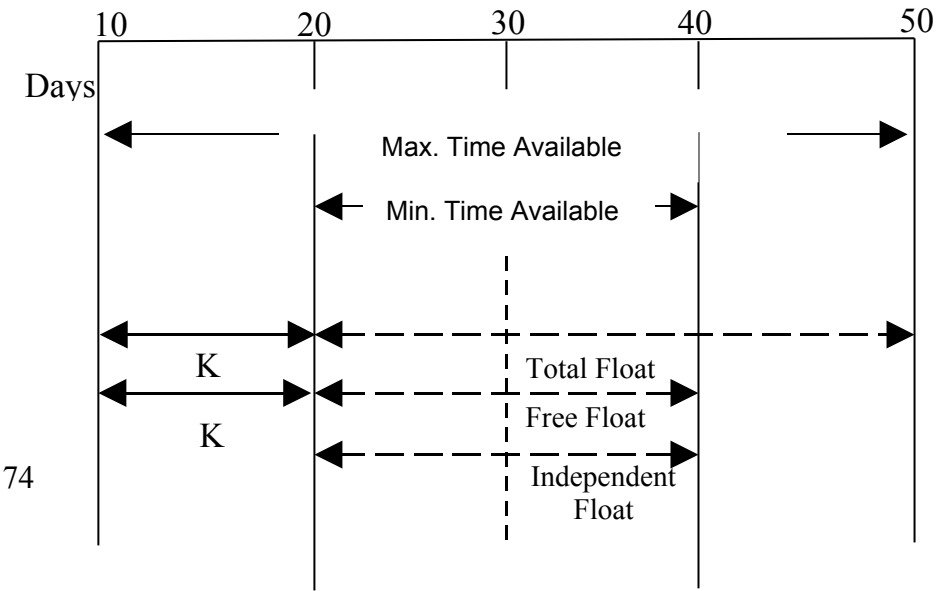
From the figure above, EST = A + C
= 3 + 5 = 8
Project duration = A + C +F
= 3 +5 +7 = 15

The Backward Pass calculates the latest time at which a preceding activity can finish without increasing the project duration. Where there are two or more routes back to an event, the longer route is taken.

Event 2 can be reached through Activity F (7 weeks) or Activities E/G (6 weeks) so that LST = 15 - 7 = 8.

This also represents the Critical Path. The Critical Path is the path or paths through the network where the EST's and LST's are identical.

B, D, E, G are non-Critical activities, that is, they have spare time or float available. There are three types of floats: Free, Independent and Total Float as illustrated in the diagram below (Lucey: 1983).



a. **Total Float** = Latest Head Time – Earliest Time – Activity Duration

Total Float = 50 – 10 – 10
= 30 days

This represents the amount of time a path of activities could be delayed without affecting the overall project duration.

b. Free Float: - is the amount of time an activity can be delayed without affecting the common amount of a subsequent activity at its earliest start time but may affect the float of a previous activity.

Free Float = Earliest Head Time – Earliest Tail Time – Activity Duration
Free Float = 40 – 10 -10 = 20 days

c. **Independent Float: -** The amount of time an activity can be delayed when all preceding activities are completed as late as possible and all succeeding activities completed as early as possible.

Independent Float = Earliest Head Time – Latest Head Time – Activity Duration

Independent Float = 40 – 20 – 10 = 10 days.

SELF ASSESSMENT EXERCISE

1. What is a network?
2. State the common terms used in network analysis.

4.0 CONCLUSION

Network analysis is useful in the planning and control of networks in every sphere of human endeavour.

5.0 SUMMARY

Network analysis is a term used for a family of related techniques developed as an aid to project planning and control.

The common terminologies used are: Event, Activity, Dummy Activity and Network.

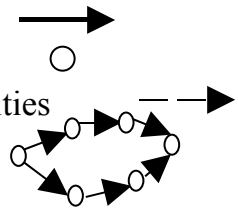
There are rules and conventions for constructing networks. The rules must be strictly complied with.

ANSWER TO SELF ASSESSMENT EXERCISE

1. A network is a directed graph of a project comprising a combination of activities, dummy activities and events.

2. The common terms used in nature analysis are:

- Activity
- Event
- Dummy activities
- Network



6.0 TUTOR-MARKED ASSIGNMENT

Identify and briefly explain the rules for drawing networks.

7.0 REFERENCES/FURTHER READING

Lucey, T. (1983). *Management Accounting*. Hampshire: DP Publications.