This book has been written for the use of both students and teachers of Colleges of Technology, Monotechnics, Polytechnics, Universities, Research Institutes and all forms of tertiary educational institutions offering construction-related courses. The book will educate students of tertiary institutions on the basics of building and construction economics, developmental principles of the construction industry, and the concept of cost management and control in the construction industry. The book will also prepare students for career progression, upon graduation, as required by the Nigerian Institute of Quantity Surveyors (NIQS), Nigerian Institute of Building (NIOB), Nigerian Institution of Estate Surveyors and Valuers (NIESV), Royal Institution of Chartered Surveyors (RICS) and other allied professional associations.

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Construction Cost Management and Control

Abdullateef Shittu

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Fundamental Principles of Construction Cost Management and Control

A Guide for Effective Teaching and Learning in Tertiary Institutions Offering Construction Courses

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FUNDAMENTAL PRINCIPLES OF CONSTRUCTION COST MANAGEMENT AND CONTROL

(A Guide for Effective Teaching and Learning in Tertiary Institutions Offering Construction Courses)

BY

Abdullateef Adewale Shittu

2022

PREFACE

This book has been written for the use of both students and teachers of Colleges of Technology, Monotechnics, Polytechnics, Universities, Research Institutes and all forms of tertiary educational institutions offering construction-related courses. The book will educate students of tertiary institutions on the basics of building and construction economics, developmental principles of the construction industry, and the concept of cost management and control in the construction industry. The book will also prepare students for career progression, upon graduation, as required by the Nigerian Institute of Quantity Surveyors (NIQS), Nigerian Institute of Building (NIOB), Nigerian Institution of Estate Surveyors and Valuers (NIESV), Royal Institution of Chartered Surveyors (RICS) and other allied professional associations.

This book will also serve as a course manual for tutors, teachers and lecturers of tertiary institutions offering construction-related courses all over the world and especially in West Africa and Nigeria. Therefore, this book will bridge the gap between the academia and private practice.

This book has been broken down into four (4) parts. The first part (I**NTRODUCTION**) addresses the general issues concerning the construction industry. The second part covered the fundamental issues with respect to the principles of construction economics. The third part of the book is on the concept of development economics. The fourth part addresses the basics of cost management and control in the construction industry. A list of references has been provided at the end of the book for further readings. The book is therefore recommended to all students and teachers of the tertiary institutions offering construction-related courses for effective teaching-learning process.

DEDICATION

This book is dedicated to the glory of God Almighty, my loving parents (Alh. A. O. Shittu, Alhaja M. F. Shittu and Alhaja M. A. Shittu) and the memories of Chief A. A. Morohunfola (my uncle), Muideen Olalekan Ibrahim (my brother in-law), Azeezat Kehinde Shittu (my daughter) and Abdulrazaq Abdulganiyu (my friend).

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CHAPTER ONE

FEATURES OF CONSTRUCTION INDUSTRY

1.1 Introduction

Before discussing the concept of construction cost management and control, it imperative to review the features of the construction industry. In view of this, the following sections will discuss the nature, importance and characteristics of the construction industry among other issues.

1.2 Nature and Scope of the Construction Industry

The construction industry has a number of characteristics common to both manufacturing and service industries. Certainly, as in manufacturing, these are physical products, and often times these products are massive in size, cost and complexity. In other words, construction is more like a service industry because it does not require significant amount of capital when compared with industries such as steel, transportation, petroleum and mining.

The construction industry is essentially an assembly of industries, assembling the products of other industries. The designer's intentions are expressed in drawings, documentation and skilled operatives guided by high level management to undertake the work of construction and assembling of components on site. Therefore, the construction industry embraces a wide range of loosely integrated organisations that collectively construct, alter and repair a wide range of different building and civil engineering structures (Ikupolati & Olaleye, 2016).

The construction industry cannot significantly influence the demand for its output or control the supply. This is because a wide range of economic factors influence the extent of activities in the industry, and these include the general economic climate, interest rates, credit availability and extent of control of public sector spending. The demand fluctuates largely with natural needs and the state of the economy. Two categories of clients can be identified in the construction industry. These are:

1. Public sector (Federal, State and Local Governments, Nationalised Industries, Public Corporations, etc.).
2. Private sector (Developers, Financial Institutions, Industry and Commerce, Building Societies, Individual Promoters, etc.).

Construction products are often built for a price established through tendering process. Also, unlike manufacturing, construction does not operate at a fixed location but it takes place from site to site wherever work is available. There is also variability of the products (projects), firms undertake range of discrete projects of relatively long duration often tailored to meet client's requirements. Construction entrepreneurs must face a daunting array of risks some of which are inherent (arising from assumptions made at the time of building), some insurable (damage to property, health and life, etc.) and others transferable (conveyed to others such as sub-contractors by contractual arrangements).

Like in any other nation, the Nigerian construction industry can be subdivided into three (3) major sectors of activities as highlighted below:

(a) **Building Works:** This generally satisfies man's need for shelter and includes such diverse buildings such as houses, flats, schools, hospitals, shops, offices, factories and warehouses.

(b) **Civil Engineering Works:** This encompasses the essential services needed to make the building functional. These include roads, bridges, reservoirs, waste water systems, railways. Power stations, harbours, dams and airports. The scope, size and extent of civil engineering works are usually considerably more substantial than building works. Civil engineering works are more method related than with building works, and bills of quantities comprise large quantities of few items while building works comprise a small quantity of a large number of items.

(c) **Heavy Engineering and Processing Engineering:** These are special construction projects such as steelworks, aluminium smelter plants, cement plants, sugar plants, off shore steel platforms, shipyards, energy centers, and nuclear processing

1.3 Composition of the Construction Industry

By definition, a contractor is one who acquires an obligation to perform work or to supply materials or finished products on a large scale at a specified price. This is a broad definition that covers many operatives outside the construction industry as well as within. Even within the construction industry, there are several specialised areas of contracting and numerous firms engaged in one form or the other. The following major categories are typical areas of operations:

1. General building contractor

2. Building trades
3. Engineering construction
4. Specialised contractor

1.3.1 General building contractor: The General building contractor is engaged in the construction of all types of residential, commercial and industrial buildings (including general builders and speculative builders).

1.3.2 Building trades: These are the domain of sub-contracting, a highly specialised and fiercely competitive field. The sub-contractor usually works under a contract with a prime contractor on a job. The major categories of building sub-contractors embrace electrical works, mechanical works, plastering, etc.

1.3.3 Engineering construction: The engineering construction category covers general works that are planned and designed by the Engineer rather than the Architect. Typical projects falling within this classification are further divided into highway and heavy engineering groups and even more specifically into grading, bridges, municipal and utility services.

1.3.4 Specialised contractors: These include marine construction, oil well and drilling contractors, chemical process plant, etc.

1.3.5 Comparison with other Industries: Unlike other industries, construction contractors employ temporary labour. They have the work schedule halted or altered by external factors. Construction projects are changing according to specifications, and fluctuating costs, which are subject to a complete lack of price stability in the future market. In view of this, the construction industry suffers in comparison with other industries, especially, when the comparison is with respect to profits.

1.4 Characteristics of the Products of the Construction Industry

The construction industry has some unique characteristics due to the physical nature of its products and demands. Some of these characteristics are highlighted below:

1. No two projects are identical; most projects are one-off designs and even with prototype construction, site characteristics and location will vary, making them unidentical.
2. The products of the construction industry are manufactured on the client's property, i.e., construction site.

3. Construction works are carried out on the site where the products will be consumed.
4. Production is not carried out under controlled factory conditions. Construction activities are therefore affected by the vagaries of weather and also of ground conditions.
5. Construction products take a long time to produce and last for many years.
6. Construction works are capital intensive.
7. Its processes include a complex mixture of different materials, skills and trades.
8. The construction industry is more of a service industry than a manufacturing industry.
9. Throughout the world, the construction industry includes a small number of relatively large construction firms and a very large number of small firms.

Building construction is the product of a diverse group of sub industries, with many individuals and organisations involved in the construction of a single structure, from the manufacture of necessary components to final assembly. As a general rule, State laws require a registered Architect or Engineer, or both, to execute the design and to make sure that the design complies with public health, zoning, and Building-code Requirements. The design must at the same time conform to the requirements of the owner. The Architect or Engineer converts these requirements into a set of drawings and written specifications that are usually sent to interested general contractors for bidding, the successful bidder or bidders in turn, subcontract plumbing, painting, electrical installation, structural frame construction and erection, and other jobs to firms specializing in these trades.

Contractors ordinarily undertake their work under the observation of an Architect or Engineer, who acts as representative of the client. State and Local inspectors review the work for general compliance with the Local Building Code. The immediate responsibility of the contractor, Architect, and Engineer ends when the Local Authorities approve the building for occupancy and the owner accepts the building. However, the contractor, Architect, and Engineer are legally responsible for any deficiencies in the construction or design for a period of several years after acceptance, the time depending on the terms of the contract and Local Laws.

1.5 Construction Equipment

The equipment used in the construction industry for construction activities are mainly **Earth Moving Equipment**. These are equipment used in heavy construction, especially civil engineering projects, which often require the moving of millions of cubic metres of earth. The removal of earth or materials from bottom of bodies of water is performed by dredges. These include:

1.5.1 Bulldozers

The primary earth-moving machine is the heavy-duty tractor, which, when fitted with endless tracks to grip the ground and with a large, movable blade attached in front, is called a bulldozer (See Figure 1.1). Bulldozers are used to clear bush or debris, remove boulders, and level ground.

Fig. 1.1: A Bulldozer (Source: Ikupolati & Olaleye, 2016)

1.5.2 Scraper

A scraper is a machine that may be pulled by a tractor or may be self-powered. It consists of a blade and a box or container. Dirt is scraped by the blade into the container. The dirt may then be released so as to form an even layer of a predetermined thickness, or be carried off for disposal elsewhere. Scrapers are used to level contour land, as in road construction. Figure 1.2 shows the picture of a typical scraper.

Fig. 1.2: A Scraper (Source: Ikupolati & Olaleye, 2016)

1.5.3 Grader

Somewhat similar to scrapers are graders, self-propelled, wheeled machines with a long, inclined, vertically adjustable steel blade. Graders are primarily finishing equipment; they level earth already moved into position by bulldozers and scrapers. A grader has a laser levelling unit mounted on its blade.; the levelling device constantly adjusts the height of the blade to ensure that the ground is made precisely flat. See Figure 1.3 for the picture of a typical grader.

Fig. 1.3: A Grader (Source: Ikupolati & Olaleye, 2016)

1.5.4 Tractor

Lightweight tractors fitted with wheels in place of tracks are used for comparatively light construction jobs. Equipped with a backhoe, which is an open scoop attached rigidly to a hinged boom, such a vehicle can dig shallow trenches; equipped with a front-end loader, a scoop shovel affixed to the front of the tractor, it can lift and carry gravel, stone, sand, and other construction materials (see Figure 1.4).

Fig. 1.4: A Tractor (Source: Ikupolati & Olaleye, 2016)

1.5.5 Dragline

Draglines and power shovels are primary forms of excavation equipment. A dragline is fitted with an open scoop supported from the end of a long boom by a wire cable. The scoop is dragged along the ground by the cable until it is filled with earth, which is then dumped elsewhere. Draglines are used primarily to excavate deep holes. Power shovels are fitted with buckets called clamshells, which dig into the earth and shovel it up. The bottom of the clamshell opens to dump the dirt into a truck for removal. See Figure 1.5 for the picture of a typical dragline.

Fig. 1.5: A Dragline (Source: Ikupolati & Olaleye, 2016)

1.5.6 Mobile Derrick Crane

The derrick crane moves heavy objects through the use of a motor, which winds cable around a winch, and a system of pulleys. See Figure 1.6 for the picture of a typical mobile derrick crane.

Fig. 1.6: A Mobile Derrick Crane (Source: Ikupolati & Olaleye, 2016)

1.5.7 Dump Truck

Dump trucks have large open beds for hauling loose materials such as gravel or soil. To empty the bed's contents, a hydraulic lift inside the truck tilts the bed, dumping the contents behind the truck. Dump trucks are common at busy construction sites, where large amounts of building materials are frequently moved (see Figure 1.7).

Fig. 1.7: A Dump Truck (Source: Ikupolati & Olaleye, 2016)

1.6 Scope of Construction Economics

Construction economics is a branch of general economics. It consists of the application of the techniques and expertise of economics to a particular area of the construction industry. Economics in general is about the choice of the way in which scarce resources are and ought to be collected between all their possible uses. Construction economics is a small part of a larger subject of environmental resources. This is concerned with the study of man's need for shelter depicting suitable and appropriate condition in which to live. It seeks to ensure the efficient use of available resources to the industry and increases the rate of growth of construction work in the most efficient manner. It includes the study of the following:

1.6.1 Client's Requirement: This involves the study of the clint's wants and needs ensuring that the designing is kept within the available funds provided by the client. The client's fundamental needs can be summarised as follows:

1. The building must meet the client's requirements.
2. The building is available for occupation on the specified date for completion.
3. The final account is close to the budgeted estimate/tender figure.
4. The construction project can be maintained at a reasonable cost.

1.6.2 Environmental Impact of Construction: This considers the wider aspect associated with planning and the general amenities affected by proposed new construction project.

1.6.3 The Relationship of Space and Shape: This evaluates the cost implications of design variables; it does not seek to limit the Architect's skill or aesthetic (beauty) appearance of the project, but merely to inform the Architect and the client of the influence of their designs on the overall cost.

1.6.4 The Assessment of Initial Cost: This factor seeks to establish an initial estimate that is sufficiently accurate for advice purposes and can be used for comparison purposes throughout the building process.

1.6.5 The Reasons for and Method of Controlling Cost: One of the client's main requirements in respect of any construction project is the assessment of its expected cost. The method used in controlling cost will vary depending on the type of project and the nature of the client. The method adopted should be reasonably accurate but flexible enough to suit the individual client's requirement.

1.6.6 The Estimation of the Life of the Building and Materials: The emphasis of the initial construction cost has moved to consider the overall life cycle costing. The spending of a little more initially can result in a considerable saving over the life of the building.

1.7 Sources of Cost Information

Cost information can be defined as the knowledge of knowing the amount of money paid for a product price or the amount spent in producing or manufacturing a commodity. However, in the construction industry, cost information simply means the knowledge of knowing the prices of building components such as of materials, plant and labour. Cost information for Quantity Surveyors and other participants in the construction industry can be classified into the following two (2) sources:

(a) Information from within the organisation
(b) Information from outside (published information)

Under the first category, the sources of cost information can be grouped into the following:

i. Priced Bill of Quantities
ii. Market Survey
iii. Cost Index

The information sources that can be grouped under the second category are as follows:

i. Technical press
ii. Consulting information services
iii. University or Polytechnic research
iv. Technical information system
v. Government literature

All these sources are hereby discussed.

1.7.1 Priced Bill of Quantities

The priced bill of quantities (based on successful tenders) is claimed to be the most effective sources of cost information. This is considered the cheapest, fastest and most comprehensive way of gathering cost information. This is so because of the fact that it is the 'house - made' dealing with projects which the Quantity Surveyor or user has full knowledge and the fact it is possible to have an idea of trends in the tender price level from tenders submitted by contractor in competition. Bill rates extracted from priced bill of quantities are less reliable than published data because of vagaries of tendering which include errors incorporated through the lack of accurate cost data or simply through human errors that has made the bill rate artificially high or low. Hence, because of great variability in contractor's pricing, price information from this source should be treated with great circumspection.

1.7.2 Market Survey

Market survey plays an important role as a meaningful source of cost information in the construction industry. It involves the firms having a feel of the current market situation on labour, plant and material through local and national labour unions, plant hiring and purchasing firms, builders' merchants, sub-contractors and suppliers of building components.

1.7.3 Cost Index

One of the most important items of cost information particularly with regard to forecasting techniques which rely on historic data (i.e., past information) is a cost index. The objective of the cost index is to measure changes in the cost of an item or group of items from one point in time to another. A base date is chosen and is usually given the value of 100. All future increases or decreases (i.e., changes) being related to this figure. For example, suppose the base date for the cost of a 50kg bag of ordinary Portland cement is =N=600.00 per bag and the current cost is =N=900.00 per bag. That is =N=600.00 would be given the value “100” and =N=900.00 would be represented by the figure “150”. The following example illustrates better.

Example 1.1

Supposing the base date cost for the cost of a 50Kg bag of ordinary Portland cement is =N=1,200.00 per bag and the current price is =N=1,800.00, =N=1,200.00 will be assigned the value 100 and =N=1,800.00 would be represented by the value 150. The cost index in relation to base can be calculated as thus:

Firstly, the index number assigned to present cost (i.e., 150 is obtained as thus:

Previous Cost = 100

Present Cost = x

By cross multiplying we have;

Previous Cost(x) = Present Cost(100)

$$x = \frac{\text{Present Cost(100)}}{\text{Previous Cost}} = \frac{=N=1{,}800.00 \times 100}{=N=1{,}200.00} = 150$$

The formula below can also be used:

$$\frac{\text{Present Cost} - \text{Previous Cost}}{\text{Previous Cost}} \times 100 + 100 \quad \text{---------------------------- (1)}$$

Where Present Cost = =N=1,800 and Previous Cost = N=1,200.00

Hence, we have:

$$\frac{1800 - 1200}{1200} \times 100 + 100 = \frac{600}{1200} \times 100 + 100 = 150$$

$$\text{Cost Index} = 100 : 150 = \frac{100/100}{150/100} = \frac{1}{1.5} = \mathbf{1:1.5}$$

As the base is 100 the number of points of any subsequent index above 100 (in this case 50) also represents the percentage increase since the base date.

However, to compare cost over time in which the date we wish to update is not a base year cost but as an index of say 120, then to arrive at the percentage increase in cost where the current index is 150, the following calculation is adopted:

$$\frac{\text{Current Index} - \text{Previous Index}}{\text{Previous Index}} \times 100\% \text{ ---------------------------------- } (2)$$

Where Current Index = 150 and Previous Index = 120

Hence, we have:

$$\frac{150 - 120}{120} \times 100\% = \frac{30}{120} \times 100\% = \mathbf{25\%}$$

1.7.3.1 Classification of cost indices

Cost indices can be classified in to two namely:

i. Building Cost Index
ii. Tender Cost Index

i. Building Cost Index

This is usually based on building costs which are the cost incurred by a builder in performing building work and embraces such items as wages and operatives, price of materials, plant costs, rates, rents, overheads, taxes, etc.

ii. Tender Cost Index

This is usually based on tender prices which represent the price a client must pay for a building and includes building cost but also takes account of market considerations and allows for profits and the builder's forecast of cost changes throughout the contract period.

1.7.3.2 Uses of cost indices

A number of uses to which cost index numbers can be put in the construction industry can be summarised below:

i. **Updating elemental cost analysis:** This is perhaps the most commonly used by the Quantity Surveyor and is essential part of the theoretical elemental cost planning process. Tender information of past projects can be brought up to current costs for budgeting purposes; although it should be realised that great care is required when updating information beyond a period of say two (2) years.

ii. **Updating for research:** It is extremely difficult to obtain large quantities of cost data relating to same point in time in order to analyse trends and patterns for cost research. By bringing cost information obtained at a number of different points in time to a common date by the use of an index, large sample of data can be examined.

iii. **Extrapolating of existing trends:** By plotting the pattern of cost measured by an index, it may be possible to extrapolate a trend into the future. By applying the indices to work undertaken during a specified period, it is possible to evaluate, to an acceptable degree of reliability, the increase in costs of resources to the financial control of contract, which, contain a fluctuation clause to be exercised more speedily and with less ambiguity.

iv. **Identification of changes in cost relationship:** If a cost index is prepared for the different components of a building of for alternative possible solutions to a design problem (e.g., steel Vs reinforced concrete frame), then it is possible to see the changes in the relationship between one component and another overtime. It may then be possible to identify when one solution appears to be a better proposition than another.

v. **Assessment of market condition:** Quantity Surveyors are particularly interested in the price their clients have to pay for a building/project/facility. If the index will measure the market price, as opposed to the changes in the cost of resources, then a measure of current market conditions can be obtained which is of enormous benefit in updating and forecasting cost.

1.7.3.3 Challenges of cost indices

Cost Index method suffers from the following drawbacks:

(i) Cost index assumes that there is rise or fall in all the construction materials and labour at the same time. This fact generally proves far from truth.

(ii) This method does not take into account the availability of cheap labour and local materials. It also does not reflect seasonal variation in the prices of materials and labour.

(iii) The cost index varies with different types of buildings, use of building, number of floors, specification of work, etc. Hence it is not possible to have all purpose cost index for the construction work.

(iv) The prices of materials vary from place to place and even from shop to shop. So, it is advised to use whole sale prices rather than retail prices.

(v) Modern design criteria, better planning, modern methods of construction, cause of considerable economy in construction cost. Hence the weights allocated to important items should be constantly reviewed and modified to get the specific realistic outcome.

1.7.4 Technical Press

In free market development countries, some technical magazines and journals in the field of design and construction management are available that publish construction cost information such as elemental cost analysis, cost of construction resources, projections, regional economic reports, analysis of the economic performance and cost of different types of buildings. The information from the technical press is the least comprehensive and least trusted source of construction cost information in Nigeria.

1.7.5 Information Services

This is a system whereby each Quantity Surveying offices are persuaded to supply their own elemental cost analysis to a central body, then a large pool of information could be gathered which could then be disseminated to the contributing members. If these analyses could be supplemented with other more general information on trends and economic indications, then a careful service could be provided for the profession of Quantity Surveying and other participants in the construction industry in general.

1.7.6 University of Polytechnic Research

The education institutions have now begun to establish programmes of work which will assist in developing a general theory for cost prediction and control and to investigate the reasons for, and the degree to which, costs change in relation to design and economic variables. Papers on such research are beginning to be published and it is envisaged that providing funds are forthcoming. This will provide a large source of cost information in the future for Quantity Surveyors and other participants in the construction industry in general.

1.7.7 Technical Information System

This is linked to office library system available to the building professions, which contains a collection of the current trade literature relating to building products. Their major purpose is to provide a ready reference for the practitioner on specification and performance of a wide variety of building products. At one time, it was common to find current price list included but with problems of updating this information so frequently such cost information is very seldom published and circulated except on request. Whilst the firm's data represent the two main sources for the cost planner, there is a further source available for some types of work, which in some way is a combination of the two. This is obtaining information from specialist sub-contractors, specialist consultants, or even sometimes a building firm.

Like published information, this suffers from remoteness, but because there is usually an element of personal contact involved. It is possible to explain and discuss exactly what is involved. Such information can be very useful in connection with various forms of roofing, flooring, windows, doors, cladding, finishes, framing, landscaping and in particular engineering services. If prices are obtained from specialist and contractors, there are several additional points to watch. Not only must the cost planner remember to add the builder's profit and perhaps discount allowance to the figures quoted, but if the field is one with which he/she is not familiar, he/she should obtain an indication of the extra facilities which the builder may have to provide. In some sections of the industry, a price for site installation simply covers the cost of building a specialist supervisor, the builder having to do most of the hard work. Other people may be almost entirely self-sufficient.

1.7.8 Government Literature

As the government has gradually become the major client of the construction industry, it has steadily increased its involvement in research and development aspects of cost forecasting and control. Central government has promoted a number of working parties in the industry and has sponsored research in several areas relating to cost. Most of the major government departments which undertake large construction programmes have standardised their procedures for budgeting and have made recommendations as to normal cost planning and control practices. These guidelines are sometimes related to cost yardsticks which provide a good deal of cost information (especially at the brief stage) in their own right.

CHAPTER TWO

THE CONCEPT OF COSTS IN BUILDING

2.1 Types of cost in Building

The types of cost in relation to building construction can be broken down into six (6) components. These are hereby discussed.

2.1.1 Fixed Costs

These are costs which do not vary directly with output and for this reason, they are sometimes known as indirect costs. They remain relatively constant in a short term irrespective of the level of activities in the firm. As a matter of fact, these costs have to be met whether or not a firm produces any goods for example, overhead cost.

2.1.2 Variable Costs

These are sometimes referred to as operating cost or direct cost. They are those costs which vary directly with output. In other words, variable costs are those costs that fluctuate with increase or decrease in the level of work undertaken. For example, material cost.

2.1.3 Full Cost

This is also known as total cost. It is the addition of both the fixed and variable costs. It is the total amount of money incurred in the cause of production. To a contractor, full cost represents the contract sum of the given work undertaken.

2.1.4 Marginal Cost

This refers to the changers in the total costs resulting from one unit chance of output. It is represented as "MC". Therefore:

$$MC = \frac{\text{Increase in Total Cost}}{\text{Increase in Output}} = \frac{\text{Increase in TC}}{\text{Increase in Output}}$$

For example:

1,500 number of 6" hollow sandcrete blocks at the rate of =N=150.00/block

= =N=225,000.00

1,600 number of 6" hollow sandcrete blocks at the rate of =N=150.00/block

= =N=255,000.00

MC = =N= $\frac{(255{,}000.00 - 225{,}000.00)}{2{,}600 - 2{,}500}$

= =N= $\frac{30{,}000.00}{100}$

= **=N=300.00**

Therefore, the unit change = =N=300.00 – =N=150.00 = =N=150.00

2.1.5 Total Cost of Building

The total cost of building is the summation of all costs arising during the whole of its useful economic life and it is made up of initial cost and the cost-in-use.

2.1.6 Initial Cost

It is the capital or initial expenditure on an asset when first provided. Initial cost includes the cost of land, construction and professional fees. This can be broken down to include the following:

1. The cost of acquiring interest on the land.
2. Ground rent paid before the development is completed.
3. Physical preparation of the site, including any demolition (in urban areas), clearing of bush (in rural areas), and providing or extending the infrastructure (services, drainage and paths).
4. Preparation of legal documents on site, including building permits (planning permit must be obtained before any interest in land will be obtained).
5. Cost of construction of the building and external works.
6. Professional fees.
7. The cost of financing the project before it reaches its earning capacity.

Worked Example 2.1:

The construction of a proposed development is estimated at =N=5,000,000.00 for the building and =N=600,000.00 for external works, professional fees will amount to 12 ½ % of the cost of the work. The public relation (PR) money for the traditional council for land is =N=20,000.00 paid in advance and a ground rent of

=N=10,000.00 which must be paid at the beginning of each year. The building permit fees is =N=20,000.00 and expenses are =N=5,000.00 both of which are payable before the work commences. Money can be borrowed at 12% per annum and the developer wants to take 20% profit on his expenditure. If the work will take 3 years before completion, what will be the selling price of the building?

Solution:

Cost of acquiring interest in land:

PR Money: =N=20,000.00 x CAF for 3 years at 12%

(CAF from Table = 1.4049) = 20 x 1.4049 = =N=25,100.00

1 Ground rent during building project: =N=10,000 for 3 years paid in advance x CPD

Amount per period, where payment is made at the beginning of period at 12%: = =N=10,000 x 3.7793 = =N= 37,793.00

2 Legal preparations:

Building permits = N20,000.00

Legal fee = N5,000.00

N25,000 x CAF

(CAF from Table = 1.4049)

= N25,000 x 1.4049 = =N= 35,123.00

3 Cost of construction:

Cost of building = N5,000,000.00

External works = N600,000.00

= N5,600,000.00 = =N= 5.600,000.00

4 Professional fees: 12 ½ % of cost of construction = =N= 700,000.00

5 Financing: say equal to half cost x CPD interest:

For 3 years at 12% = N3,200,508 x (1.4049) = =N= 1,275.44

=N= 7,676,451.00

Developer's profit: 20% = =N= 1,535,290.00

Selling Price of the Development ------------------------------ =N= 9,211,741.00

2.1.7 Cost-in-use or User Cost

The evaluation of the efficiency of an asset throughout its productive life cycle can be carried out using the cost-in-use technique. Development appraisals concentrate on its initial cost of development project, but when the completed project is occupied and in use, the maintenance and operational costs, will require the estimation and planning of expenditure pattern over the life span of the building. The user of the building will need a reliable tool to plan, monitor and manage the real costs associated with the maintenance and operational use of the building. The cost-in-use technique has been developed to address those problems specifically. User cost can be divided into two main sections: Running and Occupational Charges.

2.1.7.1 Running cost

This is the cost incurred in keeping the facility in a functional state. These include maintenance, operational services (e.g., operating of plants and equipment, cleaning, caretaking, etc.), fuel and power.

2.1.7.2 Occupational charges

These include rates and taxes, ground rents, insurances, management expenses and modification and alterations.

2.1.8 Life Cycle Costing

Life cycle costing, also referred to as ultimate cost or total cost, is a term of cost prediction by which the initial constructional cost and associated costs and annual running and maintenance costs of a building or part of a building can be reduced to a common measure. This common measure is a single sum which is the annual equivalent cost or the present value of all cost over the life of the building. The concept of life cycle costing will be discussed in detail as a separate lecture series in this book.

2.2 Inventory Costing

The concept of inventory costing deals with proper record-keeping with regards to the receipt, storage and management of materials in construction projects. This is hereby discussed.

2.2.1 Last-in-first-out (LIFO)

In this method, the last batch of materials received are issued out first at the price of the latest supply received into the store. Until all units from the last batch have been completely issued out, no part of the preceding batch can be issued out (assuming 3 batches of cement came in @ =N=1,200; =N=1,400 and =N=1,600 respectively, the batch worth =N=1,600 each would be issued first and the valuation will be on its value).

Worked Example 2.2:

Table 2.1: Materials Received and Issued to Site

MATERIALS RECEIVED			MATERIALS ISSUED TO SITE	
Date	**Quantity (Bags)**	**Price Per Bag (=N=)**	**Date**	**Quantity (Bags)**
7/10/2020	100	1,550	17/10/2020	75
11/10/2020	200	1,600	19/10/2020	120
19/10/2020	150	1,570	21/10/2020	200
24/10/2020	300	1,500	29/10/2020	220

Table 2.2: Last-In-First Out

RECEIVED				ISSUED			BALANCE	
DATE	**QTY (BAGS)**	**UNIT PRICE (=N=)**	**VALUE (=N=)**	**QTY (BAGS)**	**UNIT PRICE (=N=)**	**VALUE (=N=)**	**QTY (BAGS)**	**VALUE (=N=)**
7/10/2020	100	1,550	155,000				100	155,000
11/10/2020	200	1,600	320,000				300	475,000
17/10/2020				75	1,600	120,000	225	355,000
19/10/2020	150	1,570	235,500	120	1,570	188,400	255	402,100
21/10/2020				200	1,570 x 30 1,600 x 125 1,550 x 45	316,850	55	82,250
24/10/2020	300	1,500	450,000				355	535,250
29/10/2020				220	1,500	330,000	135	205,250

The balance left is 135 bags and the value is =N=205,250.00.

2.2.2 First-in-first-out (FIFO)

This method unlike the LIFO is based upon the pre-assumption that the first items to be received will be issued out first. The principle uses the price of the first batch received and until all the units from the first batch are issued out, none out of the latest batch can be issued out. This method is preferably used for perishable materials.

Worked Example 2.3:

Table 2.3: Materials Received and Issued to Site

MATERIALS RECEIVED			MATERIALS ISSUED TO SITE	
Date	**Quantity (Bags)**	**Price Per Bag (=N=)**	**Date**	**Quantity (Bags)**
7/10/2020	100	1,550	17/10/2020	75
11/10/2020	200	1,600	19/10/2020	120
19/10/2020	150	1,570	21/10/2020	200
24/10/2020	300	1,500	29/10/2020	220

Table 2.4: Last-In-First-Out

RECEIVED				ISSUED			BALANCE	
DATE	QTY (BAGS)	UNIT PRICE (=N=)	VALUE (=N=)	QTY (BAGS)	UNIT PRICE (=N=)	VALUE (=N=)	QTY (BAGS)	VALUE (=N=)
7/10/2020	100	1,550	155,000				100	155,000
11/10/2020	200	1,600	320,000				300	475,000
17/10/2020				75	1,550	116,250	225	358,750
19/10/2020	150	1,570	235,500	120	1,570 x 25 1,600 x 95	190,750	255	403,500
21/10/2020				200	1,600 x 105 1,570 x 95	317,150	55	86,350
24/10/2020	300	1,500	450,000				355	536,350
29/10/2020				220	1,570 x 55 1,500 x 165	338,850	135	202,500

The balance left is 135 bags and the value is =N=205,250.00.

2.2.3 Average costing (AVCO)

There are different kinds of average prices but the most commonly used is the weighted average. In this case, the price is arrived at by dividing the total values of stocks of a given item by the total quantity and a new price is calculated on each item whenever the new delivery is made and as such, supplies are made at the new price so arrived at.

Worked Example 2.3:

Table 2.5: Materials Received and Issued to Site

MATERIALS RECEIVED			MATERIALS ISSUED TO SITE	
Date	**Quantity (Bags)**	**Price Per Bag (=N=)**	**Date**	**Quantity (Bags)**
7/10/2020	100	1,550	17/10/2020	75
11/10/2020	200	1,600	19/10/2020	120
19/10/2020	150	1,570	21/10/2020	200
24/10/2020	300	1,500	29/10/2020	220

Table 2.6: Average Costing System

RECEIVED				ISSUED			BALANCE	
DATE	**QTY (BAGS)**	**UNIT PRICE (=N=)**	**VALUE (=N=)**	**QTY (BAGS)**	**UNIT PRICE (=N=)**	**VALUE (=N=)**	**QTY (BAGS)**	**VALUE (=N=)**
7/10/2020	100	1,550	155,000				100	155,000 (opening stock)
11/10/2020	200	1,600	320,000				300	475,000
17/10/2020				75	1,583.33	118,749.75	225	356,250.25
19/10/2020	150	1,570	235,500	120	1,583.33	189,999.60	255	401,750.65
21/10/2020				200	1,575.49	315,098.00	55	86,652.65
24/10/2020	300	1,500	450,000				355	536,652.65
29/10/2020				220	1,511.70	332,574.00	135	204,078.65

Table 2.7: Computation of Average Costing

Workings	Quantity	Values (=N=)
N155,000 + N320,000 = N1,583.33 300 bags	225 bags	356,250.25
	255 bags	401,750.65
	55 bags	86,652.65
N401,750.65 = N1,575.49 255 bags	355 bags	536,652.65
N536,652.65 = N1,511.70 355 bags	135 bags	204,078.65

Balance left is 135 bags and the value is =N=204,078.65. Generally, the LIFO method is preferred in the procurement of materials on site as can be seen in the above examples. The value of the 135 bags was =N=202,250.00.

2.2.4 Benefits of Inventories

The following are the main benefits of inventories in the construction industry.

1. Provision of protection against variation in demand.
2. Inventories give protection against delivery delays.
3. It ensures judicious use of materials.
4. It averts potential loss situation that could arise as a result of shortage of materials on site.
5. It provides additional tools for cost planning and cost control.

CHAPTER THREE

BUDGETING

3.1 Definition of Budget

A budget is a formal statement of anticipated or forecasted revenue and expenditure; usually for a period not exceeding one year. It is a forecast of the operations of the business and its expenditure in terms of revenue. A budget acts as a standard of measure against which actual performance may be compared. A budget would normally take into account the overall policy of the organisation. They are based on past records or previous activities of the organisation which is adjusted for future expectations. Budgets are expected to cover all the different aspects of the organisation's operations. That is each unit of the organisation has a budget which is integrated or aggregated to produce master budget.

According to the Institute of Cost Management (ICMA) (2000), budgetary control is the establishment of budgets, relating the responsibility of the executives to the requirements of a policy and continuous comparison of actual with budget results to secure by individual action, the objective of that policy so as to provide a basis for its revision. Budgetary control therefore involves the following:

1. Setting targets;
2. Monitoring progress; and
3. Taking corrective actions where and when necessary.

3.2 Types of Budgets

The common types of budgets are sales budget, operating budget, capital expenditure budget, and cash flow budget.

3.2.1 Sales budget

This is a forecast of the volume of turnover comprising the expected value of work period by period on the firm's project plus any other expected income generated from selling and successful claim on past contracts. It is usual practice to divide the period into months corresponding to the normal monthly schedule of payment by client for construction.

3.2.2 Operating budget

This is obtained from cost estimates of planned requirements for materials, labour, sub-contractors work, staff and overheads. The element of this budget may be updated from past contracts. The operating budget may subsequently be divided into separate functions for easy monitoring for example each contract has its individual budget. Head office functions can be divided into departments for example plants, administrative, contract services, legal, etc.

3.2.3 Capital expenditure budget

This depends very much on the nature and the volume of work expected in the coming year. A company that has a policy of purchasing its plants and equipment must be scheduled to meet the requirements of the contract. The budget sets out capital needs to meet this schedule. This budget may include other significant items of expenditure such as new premises, costly materials and special items for contract or if old plants have to be replaced.

3.2.4 Cash flow forecast

This is produced by integrating sales, operating and capital expenditure budget taking into account payment delays and retention, interest charges on loans, co-operation tax and capital allowances. In this way, period by period cash needs are determined. Where the results of the cash flow forecast indicates that the firm will not have the ability to finance this level of business, the budget must be refined to meet this constraint.

Figure 3.1 is a diagram that shows a typical budget system.

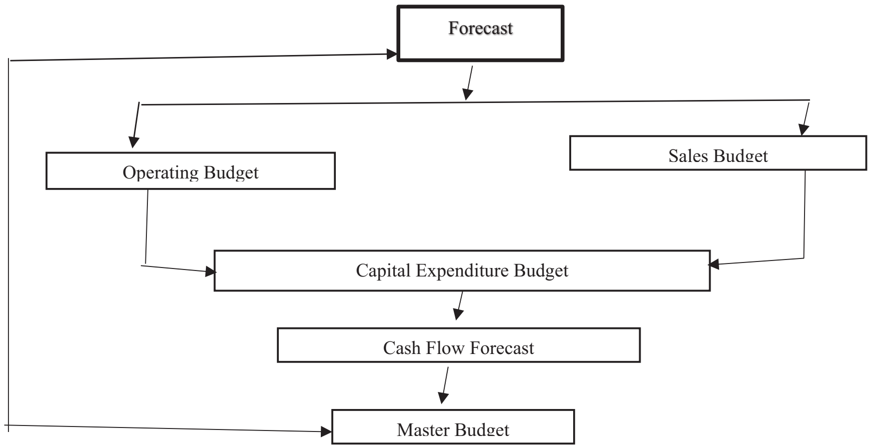


Fig. 3.1: A Budget System

The template of a master budget is presented in Table 3.1.

Table 3.1: Template of a Master Budget

1. SALES BUDGET (TURNOVER) Month a. Value of work or future contracts b. Work in progress c. Receipt from claims and other sales	Year
2. BUDGETED COST (OPERATING BUDGETS) A. CONTRACT a. Wages b. Materials c. Sub-contractors d. Rentals on hired plant/equipment e. Salaries and establishment (site overheads) B. HEAD OFFICE COST a. Salaries b. Rent rates c. Insurance d. Lighting, etc.	
3. BUDGETED TRADING PROFIT a. Depreciation on plant and equipment b. Expected profit before interest charges and tax	

Source: Ikupolati and Olaleye (2016)

3.3 Reasons for Budgeting

Budget is required for the following reasons:

1. To provide a basis for controlling the financial performance of an organisation.

2. It acts as a standard of measurement against which actual performance can be controlled.
3. It serves as a basis for negotiating overdraft facilities from banks.
4. It provides an indication or early warning signals of deviation which would necessitate corrective measures to be taken.

3.4 Cash Flow in an Organisation

Cash flow in an organisation is simply cash-in-cash-out, that is transfer of money into and out of the company. The need for "cash flow forecasting" is important in order to make provisions for difficult times before they arrive. Cash flow forecast is based on assumptions and these assumptions change. They are produced frequently and should be simple to understand. While preparing cash flow, we must take into consideration: payment delays, retention policies, interest on loans, co-operative taxes, etc.

3.4.1 Benefits of cash flow

The benefits of cash flow are:

1. It provides information for adequacy or inadequacy of cash resources and provides an early warning signal about cash requirement.
2. It allows the opportunity for making provision for difficult times.
3. In times of inflation, one can avoid embarrassing cash deficits when replacing old equipment at new inflated cost.

3.4.2 Factors that affect cash flow

The factors that affect cash flow are:

1. **Duration of the project:** Cash flow is better prepared to cover long duration.
2. **The profit margin:** The anticipated profit a contractor expects determine the funds he/she will be willing to put into executing the project.
3. **Retention conditions:** The lower the amount of the contractor's money withheld, the more funds he/she has to inject into the project.
4. **Delay in receiving payment from the client:** When a client does not honour certificates as at when due, it reduces the amount of money the contractor has to execute the project.

5. **Credit arrangement with subcontractors and suppliers:** The value of credit facilities available to the contractor also determines the extent the contractor can go.
6. Delay in settlement of outstanding claims.

3.5 Requirements of a Forecasting System

For a cash flow forecast to be meaningful, it must be done regularly. The method must be simple and easy to do, yet adequate enough for the purpose. The following data are needed for cash flow forecasting:

1. A graph of value versus time; value being the money a contractor will be paid for doing the work.
2. The measurement and certification interval.
3. The payment delay between certification and the contractor receiving cash.
4. The retention conditions and retention payment arrangement.
5. A graph of cost versus time; the contractor's cost liability arising from labour, plants, materials, subcontractors and other cost heading are necessary.
6. The project cost broken down into the above items.
7. The delay between incurring a cost liability under each cost heading and meeting that liability.

Figure 3.3 is the graph of value versus time needed to derive 'cash in'. This can be obtained by producing project plans in network or bar charts form and calculating the value of each activity and summing the value in each time period of either weeks or months. Figure 3.2 shows a simple example of value versus time calculated from the project plan. Usually, calculations are done on a cumulative basis and so, the cumulative value versus time is produced by a running total over each time period, as presented in Figures 3.3 and 3.4.

Activity	Time in Months (value in '000)											
	1	2	3	4	5	6	7	8	9	10	11	12
Excavate	1	1										
Concrete Foundation		0.5	2									
Ground Floor Slab			0.5	0.5								
Columns to Floor 1				2	0.5							
Floor 1					2	0.5						
Columns to Floor 2						2	0.5					
Floor 2							2	0.5				
Columns Floor 2 to Roof								1	1			
Roof Structure									1	0.5		
Cladding								3.5	1	0.5	0.1	
Services									2	0.5	0.1	
Finishes											0.3	0.5
Value in Months	1	1.5	2.5	2.5	2.5	2.5	2.5	5	5	1.5	0.5	0.5
Cumulative Value	1	2.5	5	7.5	10	12.5	15	20	25	26.5	27	27.5

Fig. 3.2: A Programme of Value against Time

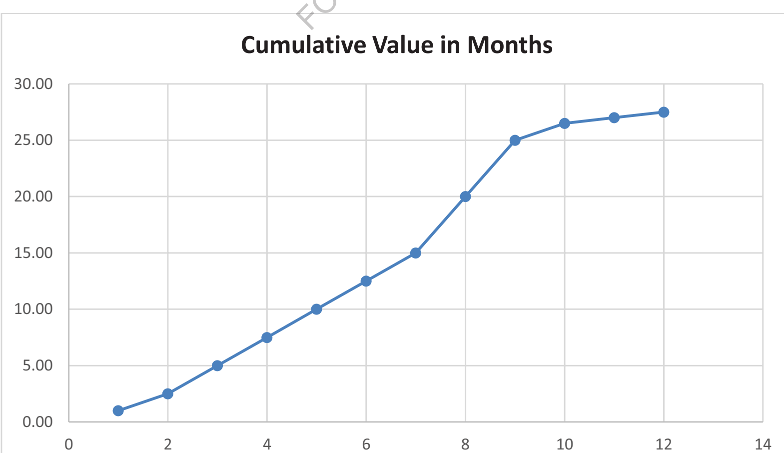


Fig. 3.3: Value versus Time (Months)

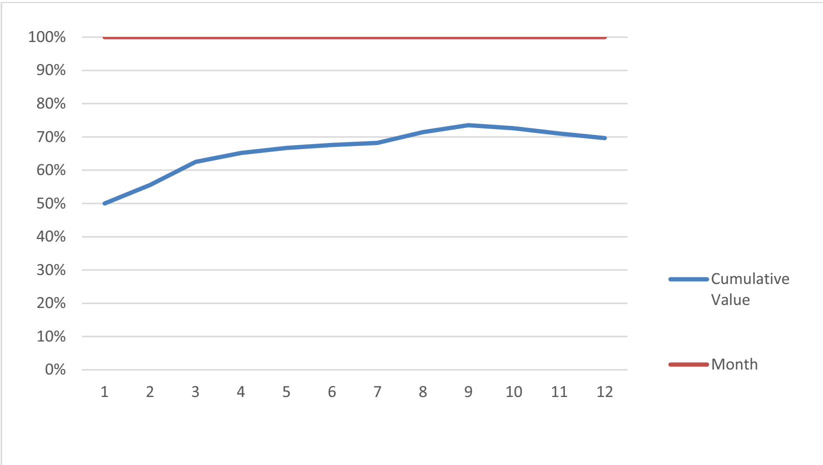


Fig. 3.4: Cumulative Value against Time

3.6 Locked-up Capital

Locked-up capitals are the funds that are meant for the contractor to execute the project but not available for the contractor to access at the particular time. Locked-up capital slows down the project as the contractor cannot access funds to execute the project. The factors that affect locked-up capital are: margin, retention, claims, front-end loading, over-measurement, back-end loading, delay in receiving payment from client, delay in paying labour, plant hirer, material suppliers and subcontractors and company cash flow.

3.6.1 Margin

Margin is the contractor's gross profit. It is among the most important factors because it determines the excess over cost and it is the excess that controls the capital lock-up. The larger the margin, the less capital is locked-up and the smaller the margin the more the capital is locked-up.

3.6.2 Retention

It is a standard in building contracts to incorporate a provision whereby the client is entitled to retain part of assessed value of the work at the interim valuation stage. The sum retained is referred to as retention. In times of very low margin, retention can reduce the 'effective margin' to zero or less.

3.6.3 Claims

Claim is the amount of money verified and payable to the contractor for any loss or expense incurred by him/her. Claims can retain a contract to its original intended level of profit. However, as the settlement of claims are normally subject to some delays, the settlement of claims is important to a company's cash flow and therefore it is important that claims are settled as at when due.

3.6.4 Front-end Loading

This is a device whereby the earlier items in the bill carry higher margin than the later items for example, if a contractor gets the bulk of money at the beginning of the project, he/she would need more cash when the project is rounding up thus affecting his/her cash flow.

3.6.5 Over-measurement

This is where the amount of work certified in the early months of a contract is greater than the amount of work done. This is compensated for in later measurement.

3.6.6 Back-end Loading and Under-measurement

Back-end loading is the opposite of front-end loading. Under-measurement is opposite of over-measurement.

3.6.7 Delay in Receiving Payment from Client

The time lag between interim valuations, issuing of certificates and receiving payments is an important variable in the calculation of cash flow. Monies go out into many destinations such as labour, plants, materials, etc. Money comes in from only one source (the client) and any delay will cause capital lock-up.

3.6.8 Delay in Paying Labour, Plant Higher, Material Supplier and Sub-contractors

The time interval between receiving goods or services and paying for them is the credit the contractor receives from suppliers.

3.6.9 Company Cash Flow

An additional key factor that affects cash flow is the timing of contract starts. If several new contracts start within few weeks of each other, the maximum negative cash flow can occur around the same time.

CHAPTER FOUR

VALUATION TABLES

4.1 Introduction

This chapter elaborately discusses various valuation tables and gives worked examples to explain each of the tables. Further worked examples on the use of valuation tables will be shown in subsequent chapters on cost-in-use studies, life cycle costing and cash flow forecasting.

4.2 Types of Valuation Tables

The most common types of valuation tables are discussed in this section under different sub-sections.

4.2.1 Compound Amount Table $(1+r)^n$

The compound amount table gives the result of investing one Naira (=N=1) at a given rate of interest (r) over a period of years. It is expressed as: $(1+r)^n$ where 'r' is the rate of interest per annum, while 'n' is the number of years. The figure obtained by this formula (or that shows the compound interest table) is the factor at which the original investment is multiplied to obtain the amount which will be realised after the given number of years have expired. The calculation needs not be limited to annual period where the interest per annum is given. The interest may be changed quarterly or monthly, in which case the rate is divided by 4 or 12 as the case may be and the period will be the actual number of quarters or months during which the investment is made.

Example 4.1

i. CAF for 7 years at 11 ½ %; Formula: CAF = $(1+r)^n$

Where: r = 11 ½; n = 7

Substituting values in formula, we have:

= $(1+0.115)^7$ = 2.1425

ii. CAF for 13 years at 11 ½ % = 0.015; Formula: CAF = $(1+r)^n$

Where: r = 11 ½ % = 0.115; n = 13

Substituting values in formula, we have:

$= (1+0.115)^{13}$ = 4.117

iii. CAF for 19 years at 11 ½ %; Formula: CAF = $(1+r)^{n}$

Where: r = 11 ½ =0.115; n = 19

Substituting values in formula, we have:

$= (1+0.115)^{19}$ = 7.911

4.2.2 Present Value Table $\left(\frac{1}{(1+r)n}\right)$ ---------------------- (4.1)

This table gives a factor to multiply an amount which is required in the future, at a given rate. It is the present value of the expenditure or receipt of the factor date. It is the reciprocal of the compound amount table. It is expressed as:

$$\frac{1}{(1+r)n}$$

Where; 'r' is the rate of interest per annum and 'n' is the number of years.

Example 4.2
What is the present value (PV) for expenditure in 7 years, 13 years and 19 years at 11 ½ %?

i. PV for 7 years at 11 ½ %:

Formula for PV = $\frac{1}{(1+r)n}$

Where; r = 11 ½ % = 0.115, n = 7. Substituting values in the formula:

$= \frac{1}{(1+0.115)7}$ = 0.4667 = 2.1425

ii. PV for 13 years at 11 ½ %:

Formula for PV = $\frac{1}{(1+r)n}$

Where; r = 11 ½ % = 0.115, n = 13. Substituting values in the formula:

$= \frac{1}{(1+0.115)13}$ = 0.2429 = 4.1170

iii. PV for 19 years at 11 ½ %:

Formula for PV = $\frac{1}{(1+r)n}$

Where; r = 11 ½ % = 0.115, n = 19. Substituting values in the formula:

$= \frac{1}{(1+0.115)19}$ = 0.1264 = 7.9110

4.2.3 Compound Amount per Period Table $\left(\frac{(1+r)^n - 1}{r}\right.$ ------------- (4.2)

where an income is received at a regular interval and is invested at a compound interest, the sum realised at the end of the given period could be obtained by the compound amount per period table. This is expressed as:

$$\frac{(1+r)^n - 1}{r} \text{ ----------------------- } (4.2)$$

where ‘r’ is the rate of interest per annum and ‘n’ is the number of years.

Example 4.3
What is the compound amount per period for an investment at 11 ½ % for 7 years, 13 years and 19 years?

i. Compound amount per period for an investment at 11 ½ % for 7 years.

Formula CAPF = $\frac{(1+r)^n - 1}{r}$

Where; r = 11 ½ % = 0.115, n = 7. Substituting values in formula:

$\frac{(1+0.115)^7 - 1}{0.115}$ = 9.935

ii. Compound amount per period for an investment at 11 ½ % for 13 years.

Formula CAPF = $\frac{(1+r)^n - 1}{r}$

Where; r = 11 ½ % = 0.115, n = 7. Substituting values in formula:

$$\frac{(1+0.115)^{13}-1}{0.115} = 27.104$$

iii. Compound amount per period for an investment at 11 ½ % for 19 years.

$$\text{Formula CAPF} = \frac{(1+r)^{n}-1}{r}$$

Where; r = 11 ½ % = 0.115, n = 7. Substituting values in formula:

$$\frac{(1+0.115)^{19}-1}{0.115} = 60.094$$

Example 4.4

What is the compound amount of annual income of =N=100,000.00 for 20 years if the rate of interest is: (a) 8% and (b) 12%?

$$\text{Formula for CAPF} = \frac{(1+r)^{n}-1}{r}$$

For (a): where r = 8% = 0.08, n = 20 years. Substituting values in formula:

$$\text{Formula for CAPF} = \frac{(1+0.08)^{20}-1}{0.08} = 45.762$$

Formula for CAPF = 45.762 x =N=100,000.00
= =N=4,576,200.00

For (b): where r = 12% = 0.12, n = 20 years. Substituting values in formula:

$$\text{Formula for CAPF} = \frac{(1+0.12)^{20}-1}{0.12} = 75.052$$

Formula for CAPF = 75.052 x =N=100,000.00
= =N=7,205,200.00

4.2.4 Uniform Investment per Period Amounting to Utility or Sinking Fund Table

$$\frac{1}{(1+r)^{n}-1} \text{ -------------------------------- } (4.5)$$

Example 4.5

What is the sinking fund value for an annual investment to realise =N=100,000.00 in 20 years' time with interest rate (a) 7 % and (b) 12%?

SFF is given by $\frac{1}{(1+r)^n-1}$

(a) Where r = 7 %, n = 20 years. Substituting values in formula:

SFF = $\frac{1}{(1+0.07)^{20}-1}$ = 0.0244

Therefore, SFF = =N=100,000.00 x 0.0244

= =N=2,440.00

(b) Where r = 12 %, n = 20 years. Substituting values in formula:

SFF = $\frac{1}{(1+0.12)^{20}-1}$ = 0.0244

Therefore, SFF = =N=100,000.00 x 0.0139

= =N=1,390.00

4.2.5 Mortgage Repayment Table or Uniform Amount Plus Interest on Loan per Period that will Reach Unity

$$\frac{r(1+r)^n}{(1+r)^n-1} \quad \text{--------------------------------} \quad (4.6)$$

This table is used to calculate the sum of interest on observed money and the amount to invest per period so that after a given period has elapsed, the sum borrowed can be paid back. The formula can be formed by adding the rate of interest to the sinking fund (SF). This gives:

$$\frac{r(1+r)^n}{(1+r)^n-1} = \frac{r(1+r)^n-r+r}{(1+r)^n-1}$$

$$= \frac{r(1+r)^n}{(1+r)^n-1}$$ as already denoted as Equation 4.6.

As can be seen from the formula above, these factors can be obtained by multiplying compound amount table by sinking fund table = SF x CPA.

Example 4.6

What is the annual payment which might be made to repay a building loan of =N=2,000,000.00 in 40 years' time, if the interest charged on the loan and that received on the interest is 12 %?

Solution

Formula = $\frac{r(1+r)^n}{(1+r)^n-1}$

Where r = 12% = 0.12, n = 40 years. Substituting values in formula:

$= \frac{0.12\ (1+0.12)^{40}}{(1+0.12)^{40}-1}$

$= \frac{11.16611}{92.05097} = 0.1213$

Therefore, annual payment = =N=2,000,000 x 0.1213

= =N=242,600.00

4.2.6 Present Value of a Sum per Period or Year's Purchase

$\left(\frac{(1+r)^n-1}{r(1+r)^n} \right)$ ------------------------------------ (4.7)

This table is the reciprocal of mortgage repayment table and the amount will never be greater than one divided by the rate of interest (expressed as decimals). If the sum per period is received perpetually the years' purchase will be equal to one divided by the rate of interest (1/r). The table can also be constructed by multiplying the present value table by the compound amount per period table. PV table = $\frac{1}{(1+r)^n}$ x $\frac{(1+r)^n-1}{r^n}$

Example 4.7

What is the present value of =N=10,000.00 per annum for 20 years if the interest rate is (a) 8% and (b) 12%.

Solution

Year's purchase factor (YPF) = $\frac{(1+r)^n-1}{r(1+r)^n}$

Substituting values in formula:

(a) r = 8% = 0.08, n = 20 years.

Therefore, YPF = $\frac{(1+0.08)^{20}-1}{0.08(1+0.08)^{20}}$

$= \frac{3.66096}{0.37288} = 9.8181$

YPF = =N=10,000.00 x 9.8181 = =N=98,181.00

(b) r = 12% = 0.12, n = 20 years.

Therefore, YPF = $\frac{(1+0.12)^{20}-1}{0.12(1+0.12)^{20}}$

$$= \frac{8.6462}{1.1575} = 7.4697$$

YPF = =N=10,000.00 x 7.4697 = =N=74,697.00

4.2.7 Dual Rate of Year's Purchase

In many cases in practice, the amount of interest received on sinking fund investment is less than the amount paid on borrowed money. To construct this "dual rate table", the mortgage repayment table can be built by taking the sinking fund factor (at a lower rate of interest) and adding the interest rate for the borrowed money and the reciprocal of this figure will give the year's purchase dual rate factor.

Example 4.8

What is the PV of =N=10,000.00 per annum for 20 years at 8% of the interest on the loan to purchase the amenity to 12%?

Solution

Dual rate year's purchase factor r_1 = 8%; r_2 = 12%, n = 20 years.

SF at 8% = $\frac{r}{(1+r)^n-1}$

$$= \frac{0.08}{(1+0.08)^{20}-1}$$

$$= \frac{0.08}{3.66096} = 0.02185$$

= 0.02185 + 12% = 0.02185 + 0.12000

= 0.14185

Reciprocal = $\frac{1}{0.14185}$ = 7.0419

= =N=10,000 x 7.0419

= =N=70,419.00

4.2.8 Present Value Method of Comparison

This concept is comprised of annual cost and net present value (NPV).

4.2.8.1 Annual Cost

This is the total amount of money spent to keep a building in a functional state per annum. Annual cost can be divided into three levels as thus:

1. Initial (for example, building and site costs).
2. Periodic (for example maintenance and cost of repainting, etc.).
3. Running cost (for example, running cost of heating and cooling, etc.).

The initial cost that is cost involving annual sum could be dealt with in the same way as periodic cost. Each annual cost being discounted to its present value by the present value table. This may be expressed as:

$PV = Co\ (YPF)$

Where; Co is the cost per annum, while YPF is the year's purchase factor. So, the present value of project containing initial, running and periodic costs will be:

$PV = Co + Co\ (YPF) + \sum (PVF \times Cp)$

Where; Co represents initial cost; and Cp represents a cost in future period.

4.2.8.2 Net Present Value (NPV)

When evaluating building projects which are to be let or leased out to occupiers or disposed of by sale, there will be income to take into account as well as cost. The incomes are considered as positive cash flow and the costs as negative; both are discounted into their present value and the net effect found.

NPV = PV (Total Income) – PV (Total Cost). The NPV for various projects can be found out and compared. In general, the project with the highest NPV is the most profitable.

4.2.9 Annual Equivalent Methods of Comparison

A more convenient method of comparing costs of projects is by their annual equivalent cost because the initial cost of land and building is normally mortgaged or acquired by means of loans; it is often mor profitable to calculate the total annual cost rather than the present-day costs, especially since the former can be directly set against the annual rents generated or the possible alternative of leasing instead of buying. This is known as the annual equivalent (AE) method of comparison. To arrive at the annual equivalent of the initial cost of a construction project, two kinds of costs need to be considered; site and building costs

4.2.9.1 Site cost

Site cost is the amount of money spent to rent or own a site. It comprises the following:

1. Freehold: Some freehold land is held in perpetuity; the annual equivalent is the annual interest on its cost, thus taken as the discount rate (r) in the annual equivalent analysis.
2. Leasehold: Leasehold should be considered in the cost of building.

4.2.9.2 Building cost

A building is an asset which is subject to use and tear and has a finite life. Therefore, provision should be made to repay the loan at the end of the useful life of the building plus the interest on loan. The loan is met by setting up an annual sinking fund during the life of the asset which will amount to the original cost by the end of the project life. Meanwhile, there is still the annual interest to pay on the loan. This interest is now denoted as in the formula:

SF + i --------------------------- (4.8)

This represents SF installment plus interest that is the annual equivalent cost of the building.

4.2.9.3 Annual equivalent of the initial cost

The amount equivalent to the initial costs of construction projects may be derived as thus:

Cs(i) + CB (SFn + i) --------------------------------- (4.9)

Where; Cs = cost of site; CB = cost of building; SFn = sinking fund installment; and i = interest rate.

4.2.9.4 Annual costs

These need no converting since they are in the form of annual costs to start with. Thus, the formula for initial and annual cost becomes:

AE = Cs(i) + Cs(i) + Ca --------------------------- (4.10)

Where; Ca represents the annual costs of the project.

Example 4.9

Dr. Oyewobi owns a freehold interest in a light engineering works. He has recently purchased site for =N=440,000.00 in order to extend his premises. The estimated cost of constructing the proposed block extension is =N=480,000.00 and the annual running costs of routine cooling, heating, lighting and insurance include an allowance for repairs, are estimated at =N=70,000.00 per annum. The building has an estimated life span of 50 years. Calculate the cost-in-use of this extension on a 5% basis making necessary use of the sinking fund table.

Solution

AE = Cs(i) + Cs(i) + Ca   =N=   : K

Therefore:

Cost of Site = 440,000.00

AE in perpetuity interest (5%) = x 0.05 = 22,000.00

Cost of Building = 480,000.00

AE over 50 years SF factor for 50 years = 0.0048 (from table)

Interest at 5% = <u>0.0500</u>

<u>0.0548</u>

=N=480,00 x 0.0548 =

<u>26,304.00</u>

Annual Cost (AC) --

=N=<u>48,304.00</u>

Running Cost (RC) = =N=70,000.00 per annum

Annual equivalent cost-in-use = AC + RC

= =N=48,304.00 + =N=70,000.00= =N=118,304.00

4.2.9.5 Periodic cost

Certain maintenance costs occur periodically instead of annually (e.g., decoration every five years). For the purpose of the annual equivalent of comparison, periodic costs may be divided into the following categories:

1. Differing magnitudes and periods.
2. Uniform sums

3. Uniform sums with no final payment

4.2.9.6 Periodic costs comparing individual sums

The term periodic costs imply any cost which is not necessarily annual costs. In this category, we have single sum occurring at a point long after the time. Scale off the project, the problem is between the annual equivalent costs. First, find the PV at the periodic cost year "O" and then spread it forward over the life of the project in the form of annual payments. Assuming there is more than one such periodic cost, add their PVs together and convert the total amount in one operation as presented below:

$AE = \sum (PVF \text{ x } Cp)(SFn + i)$ ---------------------------- (4.11)

Where; Cp = any periodic cost

4.2.9.7 Uniform sum and periods

Where both the sums and the periods are uniform (for example, re-decorating every five years at the cost of =N=30,000.00), the formula is as follows:

$AE = Cp (SFp - SFn)$ ---------------------------- (4.12)

Where; SFp is the sinking fund factor over the uniform period and SFn is the sinking fund over the life of the project.

It is noteworthy that this formula (Equation 6.12) will only apply provided the following conditions are met:

1. End period is uniform. The end period must be uniform, that is the time interval between the last payment and year must be same at any successive payment,
2. No final payment. There must be no final payment due.

CHAPTER FIVE

INSURANCE AND BONDS

5.1 Meaning of Insurance

The existence of risks in any business concern simply means that certain costs must arise, if the risky events happen. The essence of insurance in the construction industry is to assess all possible risks, with respect to the circumstances of a particular business agreement and determine the likely costs, as well as the way and manner in which those costs shall be borne by the parties to such agreement. Therefore, risk abounds and sometimes cannot be eliminated. The only viable option is to manage the risk. Unfortunately, the costs that could need to be settled may be too enormous, for either or both parties to bear. The effort to overcome this problem therefore led to the growth of insurance industry. Insurance is thus a form of risk management (Ikupolati & Olaleye, 2016). Insurance is often seen as a social devise for providing financial compensation to unfortunate events. It is also a way of sharing losses between the parties concerned (Ibironke, 2003). Insurance has also been defined as the business of transferring risk by means of contract (Shittu *et al*., 2022). It is also regarded as a contractual arrangement whereby an insurer, in return for a predetermined premium, undertakes to meet the cost of any loss which the policy holder may incur due to some specified uncertainty events occurring during the period of the insurance. In view of these, studies have consensually seen insurance as a more than requirement needed for any business that is exposed to risk like the construction industry (Okolie *et al*., 2017; Odeyinka, 2020; Shittu *et al*., 2022). In addition, insurance cover provides the affected person with financial compensation to the extent of the cover provided.

5.1.1 Participants of Insurance Cover

The participants of insurance cover are the parties to the insurance cover. These include:

The Insured or the Customer: This is a person or organisation that is protected by the insurance policy. He/she can also be referred to as the policy holder. The insured is a person or entity buying the insurance policy.

i. **Insurer:** The insurer is the insurance company or any other organisation that provides the insurance. The insurer can also be defined as a company selling the insurance.

ii. **Insurance Agents:** These are men/women who work for insurance companies as marketers.

iii. **Insurance Brokers:** These are like consultants/advisers to the insured (customer). They act as intermediaries between clients and insurance companies. They sell, solicit or negotiate insurance for compensation.

iv. **Re-insurance Companies:** They are also known as "insurance for insurers" because insurance companies insure their big risk with re-insurance companies. They accept a portion of the potential obligation in exchange for a share of the insurance premium. The intent of re-insurance company is for an insurance company to reduce the risk associated with policies by spreading risks across alternative institutions.

v. **Loss Adjusters:** These are consultants/advisers on claims (Quantity Surveyors are directly involved here and claims are associated with construction properties). Loss adjusters are independent claim specialists who investigate large or complex claims on behalf of the insurance companies.

vi. **Co-insurers:** These are insurance companies who share risk with two or more insurance companies. It describes the splitting or spreading of risk among multiple parties.

5.1.2 Insurance Terminologies

The following terminologies are often used in the insurance business:

i. **Premium:** This refers to the amount paid by the insured to the insurance. The rate charged depends on the degree of the risk.

ii. **Insurance Policy:** This refers to the document of the insurance contract signed by the parties. It contains the detailed conditions of contract.

iii. **Subject Matter of the Insurance:** This refers to the thing to be insured. It could be physical like a car or building or a liability.

5.2 The Concept of Risk

In order to understand the concept of insurance properly, it is essential to discuss the concept of risk. Therefore, risk can be considered as the chances either big or small of harm actually, being done. The risks that exist in construction sites, during progress of works, arise because of the following possible injuries:

1. The possibilities of injury to persons.
2. The possibilities of injury to property.
3. The possibilities of damage to the works or parts of the work.
4. The possibilities of loss of materials and plant items.

Injury to persons is of two types. These are: injury to workmen who are directly engaged to work on the site and the other type is injury to persons, who are not in any form connected with the contractor's work on site. For instance, if a piece of object falls and hits a workman on site, this belongs to the former category. But if such object was to fall across the road and landed on the body of a passer-by, causing him/her bodily harm, this injury belongs to the latter category. Injury to property could arise when construction activities on site cause some nuisance to escape and therefore cause damage to a neighbouring property. For example, where subsidence of a building going on in an adjacent site or a piece of book falls off some height and across the public road to damage the body of a moving or parked car. Damage to the works may occur as a result of the fact that some element or the entire works under construction is affected by other causes like fire, tempest, earth tremors, etc. Loss of materials and plant items could occur as a result of theft or pilfering and also damage to temporary structures.

5.3 Reasons for the Contractor's Indemnifying the Client

In the various forms of contract being used in Nigeria, the contractor is usually asked to compensate the employer against various risks enumerated in the contract, and thereafter, proceed to take an insurance cover in the joint names of the employer and the contractor against the risks so listed. The reasons for this is purely on legal ground, which is traceable to the law of tort dealing with negligence, as well as property law. It is the general principle in tort, that if owner of a piece of land permits activities on his land, that invariably creates nuisance and such nuisance is allowed to escape and cause harm to some persons and property, then the landlord must be held liable for the damage caused. Therefore, the contractor working on a site is regarded as someone who has been permitted to do some work on the land by the landlord.

5.4 Types of Insurance Covers on Building Projects

There are usually three (3) main types of insurance covers that are required to the taken by the contractor to compensate the building owner as far as insurance of new building projects are concerned. These include:

5.4.1 Employer's Liability

This is workmen compensation insurance. This type is designed to protect the contractor against the injury, to be sustained by the contractor's employees on the works, out of and/or in the course of the employee's appointment. For instance, if a mason's leg is fractured as a result of a falling object from some height of scaffolding and he is disabled from such injury sustained, the contractor and building owner would have their legal liabilities protected by this insurance cover. In other words, the costs of the damages payable to the affected employee would be made under such insurance cover.

5.4.2 Public Liability

This policy protects the contractor and building owner from the legal liabilities arising out of bodily injury to third party (persons who are not employees of the contractor or building owner), as well as protection for loss or damage to third party. For instance, business escaping from a construction site and causing bodily harm to persons who are not employees of the contractor or land owner or damages to an adjoining property.

5.4.3 Insurance of the Works

This policy is designed to cover the costs arising from damage to or loss of the contract works, whilst the project is still undergoing construction, that is, before practical completion. The costs of consultants' fees are usually also included in the value of the work to be insured. The essence of this is to ensure that any fees paid to the consultants, say for re-designing or carrying out any duties in respect of the damaged works, are also borne by the insurance company. In building contracts, the value of all unfixed materials and goods that have been brought to the site or its adjacent or property certified but off-site are insurable, while the contractor's plant and temporary building are excluded from the insurance cover. In Civil Engineering, the contractor is required to insure constructional plant items against loss by damage or theft. In this perspective, the contractor and not the building owner must pay for the premiums of these items.

The three types of insurance just considered above are usually combined and referred to as Contractors All Risks (CAR) policy in the insurance market.

5.5 Classification of Insurance

Insurance can be classified into life and general insurance.

5.5.1 Life Insurance (Life Assurance)

Life insurance can be further divided into Whole Life Assurance and Endowment Assurance.

5.5.1.1 Whole life assurance

In whole life assurance, payment is made of the sum of only the death of the assured.

5.5.1.2 Endowment assurance

In the endowment assurance, payment is made either in the event of death before a specified date or survival at the expiration of the specified date.

5.5.2 General Insurance

General insurance comprises of fire insurance, accident insurance, motor vehicle insurance, workmen compensation insurance, contractor all risk insurance, goods in transit, marine and aviation, oil and gas, bonds and guarantees and miscellaneous insurance, for example professional indemnity insurance.

5.5.2.1 Fire insurance

Standard fire policy that usually covers fire due to any cause, subject to some exceptions which too may be covered with additional premium. These policies may be extended further (by paying additional premium) to include collateral damages or losses such as loss of income.

5.5.2.2 Accident insurance

This is a form of insurance policy which offers a payout when people experience injury or death due to an accident. This type of insurance does not usually cover negligence, acts of God, or natural disasters, and the policy may include restrictions such as caps on total expenses or restrictions on expenses for activities deemed risky. Many insurance companies sell accident insurance, which can be purchased as a standalone policy or bundled into an existing insurance policy.

5.5.2.3 Motor vehicle insurance

This is also referred to as automotive insurance, a contract by which the insurer assumes the risk of any loss that the owner or operator of a car may incur through damage to property or persons as the result of an accident. There are many specific forms of motor vehicle insurance, varying not only in the kinds of risks that they cover but also in the legal principles underlying them. Therefore, motor vehicle insurance can be classified into three (3): Acts only policy; 3^{rd} party only policy; and Comprehensive policy.

- **i.** **Acts-only policy:** This is the minimum cover available usually to satisfying government requirements. Cover is provided only for death or injury to a 3^{rd} party. It excludes 3^{rd} party property.
- **ii.** **3^{rd} party only policy:** This covers Acts-only policy and 3^{rd} party property. Owner's property is not covered.
- **iii.** **Comprehensive policy:** This covers both acts-only and 3^{rd} party only; it also includes owner's vehicle (not life or injury).

5.5.2.4 Workmen compensation

This policy is suitable for employers or companies employing more than ten (10) persons. Such employers are liable for any accidental death of or bodily injury or occupational diseases to workmen, as per the Workmen's Compensation Act of 1978. The policy covers the statutory liability of an employer for the death of or bodily injuries or occupational diseases sustained by the workmen arising out of and in course of employment. The Act provides a very wide meaning for the term 'arising out of and in course of employment' (for example, a workman starting from his house to the workplace is treated as in course of employment). Death of or injuries arising out of an employee's own negligence are also treated as 'arising out of employment'.

5.5.2.5 Contractors all risk (CAR) insurance

This is an insurance policy that provides compensation for loss or damage to the contract works, the plant and equipment at sites and also for the legal liability arising there from any unforeseen and sudden physical loss or damage from any cause other than those specifically excluded and not exceeding in all the total sum expressed in the schedule as insured hereby. The insurance policy protects the following aspects of contract activities: contract work itself, e.g., the buildings, roads, etc., plants and machinery on site, debris removal, professional fees, public liability and third-party property damage.

5.5.2.6 Goods in transit

This policy provides cover in respect of loss or damage to the insured goods whilst in transit as a result of: Fire, Collision or overturning of the conveying vehicle(s) and Theft.

5.5.2.7 Marine and aviation

Marine and aviation insurance covers the risks of loss, damage, expense and liability to your goods during transportation as cargo from one place to another place. For instance, from a factory located inland to the seaport and then across the seas to the address of the buyer of your goods abroad. The process of transportation includes airfreight, ocean freight and overland carriage. The insurance is to indemnify the cargo owner and/or the financiers such as banks against financial loss arising as a result of physical loss, damage, expenses incurred or liability from the transportation process. Loss can arise from the perils of the sea such as rough weather, sinking, the ports or as a result of overturning, collision of and/or theft from overland transports or air disaster.

5.5.2.8 Oil and gas

Oil and gas insurance can be defined as the insurance of all operations and assets relating to the exploration, exploitation, drilling, refining, storage and transportation of oil, gas or other energy resources. It also includes the insurance of Petrochemical risks such as insurance of assets, operations and liabilities arising out of production and consumption of intermediate and final products of chemical derived from Gas and Crude petroleum. The purpose of oil insurance is to protect all parties against the financial consequences of accident, which may lead to injury to workmen and third parties in addition to loss or damage to properties.

5.5.2.9 Bonds and guarantees

A bond/guarantee is a written undertaking issued by a bank or insurance company on behalf of a customer. The undertaking guarantees that should the principal not comply with his/her obligations under the contract leading to a claim under the bond/guarantee, bank or insurance company shall financially recompense the beneficiary. The beneficiary is indemnified for a stated amount.

5.5.2.10 Miscellaneous insurance (e.g., professional indemnity insurance)

Miscellaneous insurance is defined by individual insurance companies as the insurance policies outside their major scope of activities. The purpose of professional indemnity policy is to protect the professional man against his legal liability to pay damage to the persons who have sustained loss arising from his own professional negligence or that of his employees in the conduct of the business. The policy offers indemnity strictly on a legal basis and hence moral liabilities are not covered. The policy indemnifies the insured against all legal liabilities in respect of acts of negligence, error or omission, committed in the conduct of the insured's profession during the period of insurance.

5.6 Important Insurance Doctrines and Issues

If the premium is not paid as at when due, the insurance cover is void. Premium should be paid in at the inception as failure to pay at the inception may amount to denial of insurance cover. The following are very important in the doctrine of insurance business:

5.6.1 Rate Cutting

Some insurance companies in desperate need of business sometimes reduce premium rates to induce the customer. The insurer that offers the cheapest premium rates may not be the best in terms of service delivery just like the contractor that offers the cheapest price. Some risks may be excluded in the insurance policy by the insurance company, for example, riot, earthquake, etc. The insurance company will not be liable if losses arise from such risks. These risks are usually listed under exclusion or exception clauses. Therefore, ensure that the policy is well understood to identify the exclusion clause.

5.6.2 Minimum Excess

This is a stated value which the insured must contribute in case of a loss or damage. Consequently, any loss or damage not exceeding this value must be borne by the insured alone. This is to ensure a level or measure of self-interest.

5.7 Insurance Directly Related to Construction Activities

The specific insurance policies which are directly related to construction activities are hereby discussed.

5.7.1 Contractors All Risk (CAR) Insurance

The Joint Contract Tribunal (JCT) Conditions of Contract Clauses 19, 20, and 21 deal with risk and insurance for construction projects. These are:

1. Loss or damage to any part of the works, goods and materials on site.
2. Damage to adjacent properties as a result of the construction work.
3. Personal injury or death to persons on site (temporary works, construction plants and professional fees usually included).

Contractors All Risk is the single insurance taken to cover all the above-mentioned risks. All risks are not covered because some are exempted, for example, damages by war, riot, crises, act of terrorism, etc., and defective design, material and workmanship are also exempted.

5.7.2 Workmen Compensation Act

The Workmen Compensation Act requires employers to compulsorily insure their employees against injury or death resulting in the cause of their employment. Insurance cover taken by employers to cover for this is known as Workmen Compensation Insurance.

5.7.3 Professional Indemnity Insurance

This is the insurance taken by professionals like Quantity Surveyors, Engineers, Architects, Doctors, etc., to cover for Professional Indemnity.

5.7.4 Compulsory Insurance of Building in Nigeria

The 2003 Insurance Act makes it compulsory for a building of more than two floors completed or under construction to be insured. Defaulters will face a fine of =N=250,000.00 or 3 years imprisonment or both.

5.8 Claims for Insurance

Claims for insurance are the procedures for applying for, evaluating of, and determination of amount due to the insured in the business of insurance.

5.8.1 Stages of Claim Settlement

The various stages in claim statement are notification, evaluation/submission of claims including details and verification/loss adjustment and settlement. These are explained further as thus:

i. **Notification:** The insured makes a formal complain to the insurer giving details of what led to the claim attaching all necessary documents to support his claims.
ii. **Evaluation/Submission of claim including details:** The details submitted by the insured is evaluated by the insurer to ascertain the validity of the documents submitted and if the insured is entitled to compensation.
iii. **Verification/Loss Adjustment:** This is the stage where the insurance company decides how much money it should pay to a person or company whose property is damaged or lost by properly verifying all documents submitted and the extent of damage done.
iv. **Settlement:** This is the payment of an insurance claim. That is to say when a valid insurance claim is made, the insurer makes a payment to the policy holder. This is referred to as insurance settlement.

5.8.2 Hints to Successful Claim

If the insurance claim is to be successful, the following guidelines must be adhered to:

1. Keep the conditions of the policy, especially payment of premiums, as at when due.
2. Keep good relevant records before, during and after occurrence of any claimable events, for example, medical bills, police reports, autopsy, etc.
3. Report claims situation as soon as possible to relevant stakeholders in building projects, e.g., Architect, Quantity Surveyor or insurance company.
4. Include good details and back up documents to your claims.

5.8.3 Insurance Claims Under JCT Conditions of Contract

Clause 21 of JCT Conditions of Contract states that:

1. The contractor must maintain and require sub-contractor to maintain insurance in respect of the liabilities placed upon them by JCT Conditions of Contract in Clause 20.
2. The contractor must produce evidence of insurance to the Architect whenever required to do so (insurance policy and receipt of premium).
3. The contractor must give written notice containing details of the loss to the consultants, employers and insurance brokers. The consultant will ignore the loss in valuation of work done. The contractor will not be paid any extra money for repair or reinstatement. He should use the funds from the claim settlement (insurance company).
4. The exception clause here usually excludes war, riot, defective design, defective materials and workmanship.

5.9 Bonds

A bond or guarantee is an arrangement under which the performance of a certain contractual duties owned by one person (A) to another (B) is backed up by a third party (C). What happens is that (C) promises to pay (B) a sum of money if (A) fails to fulfil the relevant duties. In this context, (A) is commonly known as the principal debtor or simply principal; (B) is called the beneficiary and (C) is called the bondsman, surety or guarantor (Murdoch & Hughes, 2000). The common types of bonds are bid bond, performance bond, advance payment bond, retention bond and payment bond.

5.9.1 Bid Bond

This is the bond or guarantee required from tendering contractors to ensure that if awarded the contract at the contractor's price, he/she must accept failure for which he forfeits the value of the bond. The bond is obtained either at any insurance company or banks. The bond is submitted along with the tender.

5.9.2 Performance Bond

This is the bond required from a contractor when awarded a project. It provides a guarantee that the contractor will satisfactorily complete the project in accordance with the conditions of contract. If the contractor fails to complete the project, the client can get the value of the bond or part thereof from the guarantor. This bond is obtained either from banks or insurance companies.

5.9.3 Advance Payment Bond

Some projects allow some percentage to be paid to the contractor as advance payments. If such payments are to be made, some clients insist that on the provision of advance payment bond. This bond guarantee's that the contractor will use the advance payment solely for the purpose it was meant for. Failure of which the value of the bond or part thereof is demanded by the client from the guarantor. It is usually provided by the insurance companies or bank.

5.9.4 Retention Bond

This is not very common. In some insurances, the client may want to pay the contractor his/her retention monies before the defect liability period for some reasons. Before such payments are made, the retention bond ought to be demanded.

5.9.5 Payment Bond

A payment bond guarantees the owner that subcontractor's labour and supplier will be paid the monies that they are due from the principal, the owner is the obligee; the "beneficiaries" of the bond are the subcontractors and suppliers. Both the obligee and the beneficiaries may sue on the bond. An owner benefits indirectly from a payment bond in that the subcontractors and suppliers are assured of payment and will continue in performance.

CHAPTER SIX

SOURCES OF FINANCE FOR CAPITAL PROJECTS

6.1 Introduction

A capital project is deemed to be one which the owner intends to execute as an increase to his/her fixed assets and for which special funds have been allocated either for expenditure in a year or for a period of years. Such project could be in buildings, roads, water systems, electrical facilities, manufacturing plants and other industries. Finance can be defined as 'provision of money at the time it is needed'. The finance of construction/capital projects can be viewed from two perspectives. These are: private and public view points.

6.2 Private Development

This embraces all sort of development undertaken by individuals, group of individuals, companies, corporations, etc., apart from government organisations. These include residential houses, commercial buildings such as offices, shops, warehouses, and industrial buildings. A private investor may obtain finance from one of the following sources:

6.2.1 Short-Term Funds

This refers to sources from which capital can be obtained on a short-term basis of accounting period. The sources of this term include:

1. **Overdraft:** This is a source available to customers of commercial banks (overdraft arrangement for a certain period of time). It is usually the sum of money, over and above the funds in the firm's bank account up to which the bank will continue to honour cheques, which are presented for payments. This is considered to be a very flexible source of capital because the borrower only pays interest on the balance of money outstanding at any stage in time.
2. **Trade credit:** This is another source of capital available for execution of most projects. It is a system of delaying payment, due to creditors who have not yet been paid for their goods or services. It also includes delay of payment due to workers of construction firms. The construction industry is well suited for this sort of financial arrangement since completed work is paid for by the client in periodical stages.

3. **Mobilization funds:** These are known as advance payment from the client to the contracting organisation, to enable them mobilize necessary resources to the site immediately after award of contract.
4. **Down payment:** This is a system whereby the clients effect payment normally on materials through bank draft in advance to the manufacturer to enable the contractor procure such items at the key date of need.
5. **Acceptance credits:** In order to secure regular supply of input, a firm may negotiate with the supplier to accept payment by acceptance credit. The acceptance credit is a draft issued on a letter of credit accepted and payable on maturity date. By the use of acceptance credit, the selling firm is able to discount the draft once it is accepted by the bank and obtain funds before the due date.
6. **Provision for cooperation tax:** This is another source open to construction organisation, in such a way that payment of this tax is usually made one year in arrears. The cash, therefore, remains in the business during that period and acts as a valuable source of short-term funds for the execution of the project.

6.2.2 Medium-Term Funds

This refers to sources from which capital can be obtained on a medium-term basis of between two years and five years. The sources of this term include:

1. **Loans:** Loans can be obtained from a whole range of sources including banks such as development and merchant banks, other financial institutions, individuals and private bodies. In this system, a loan is arranged over a fixed period of time with a promise to repay the amount plus a stated rate of interest at intervals or at the end of the term of the loan. The borrower may be required to provide security or type of guarantee that the borrower will be able to repay the sum loaned. Although this source normally involves a lot of bureaucratic procedures thus taking almost a period of a year before granting such loan.
2. **Debentures:** This type of loan, although different from a conventional form of loan, in so far as it is offered by the firm to the investment market at a fixed rate of interest. In this case, the capital is repayable at a stated time and interest is payable irrespective of whether the firm has made a profit or sustained a loss during the period of the investment into such projects.
3. **Realisation of assets:** In a tight situation, the construction organisation may develop capital at very short notice by selling off certain assets or goods,

owned by the firm. Assets such as property, buildings, machinery, equipment or even materials. Conversion of assets can also take the form of the sale of investments within other firms.

4. **Equipment leasing:** This is an arrangement usually between two parties in contracting organisation, the lessor who is the owner of the item of equipment and the lessee who hires the equipment. This system normally involves a firm having financial difficulty to either replace an existing item of equipment or procure a new one to enable the firm execute construction work may approach and arrange with an equipment leasing company for a lease arrangement. The lessor procures the equipment with his/her money and leases it out for the lessee to pay on a fixed rental for a defined period of time. This is common among contracting firms using heavy construction equipment.
5. **Hire purchase arrangement:** This is a system in which a contracting firm acquires an item of equipment gradually without making an outright payment. In case of this system, the hire offsets the costs by paying in installments, thus the principal plus interest on the asset.
6. **Finance by intended occupier:** It may be possible to persuade the intended occupier to pay part of the sale price during erection of the building. This is often the case with houses which are built for sales.

6.2.3 Long-Term Funds

This refers to sources from which capital can be obtained on a long-term basis usually over a period of five years. These include the following:

1. **Retained profit:** These are sums of money which are not distributed to the shareholders of a company as dividends, or in the case of private firms to the owners of the business as profits, but which are re-invested within the enterprises.
2. **Shares:** These are equity in the company, and also being regarded as part of ownership in net worth of a business enterprise. There are many types of shares, but four major types as follows:
    a. **Ordinary shares:** These are the commonest type of share, the holder of which have voting rights within the company. Usually, holders of these share do not carry a fixed rate of dividend but are entitled to dividends in relation to the proportion of the surplus profits after all

other claims have been discharged. However, this is a high-risk form of investment.

b. **Preference shares:** The holders of these shares do not carry voting rights but their dividends are at a fixed rate and do not fluctuate in relation to the profit made by the company. This is suitable for investors who require a low-risk type of shareholding within a company.

c. **Cumulative preference shares:** These are safer form of investment because the holders have the rights to dividend accumulated from year to year. If the company fails to make sufficient profits to declare a dividend, then the rights are transferred to the following years.

d. **Preferred ordinary shares:** These are intermediary forms of investment between ordinary and preference shares. The shareholders generally receive their dividends at a fixed rate after the claims of preference shareholders have been met, but prior to the holders of ordinary shares.

6.3 Public (Social) Developments

These include government buildings such as office secretariat and parliament buildings, hospitals and health center, schools and other educational institutions, residential houses for government officials including barracks, civil engineering works such as roads, dams, drains, water supply, electricity, telephone and telecommunication networks and industrial engineering works such as steel complexes, refineries, and petrochemical complexes among others. These types of projects or facilities are provided by the government to fasten the growth and welfare of the people socially and sometimes security wise. A public investor (government and government agencies) may obtain finance from one of the following sources:

1. **Government Funds:** These will be available either as direct finance for government projects or as a grant for subsidy for local authority projects.
2. **Loan from Government Funds:** These are usually available at a lower rate of interest than money raised on the open market, but are very restricted as to eligibility and amount.
3. **Issue of Stock:** Local authority and public boards are empowered to issue fixed interest loan stock on the stock exchange. Full market rates of interest have to be paid and there is a long-term commitment to those which can prove very expensive if interest rate subsequently falls.

4. **Local Authority Mortgages:** These are useful ways of raising money as there is a firm commitment by both sides, but for a short period of three to five years; only that the interest rates are usually a little higher than current yield on glit edges securities.
5. **Loans from other Funds:** A public authority can borrow from its other funds (if it has any) for developmental purposes.
6. **Rates:** It is common for a local authority to raise money for development from the rates. This has the advantages that the money does not have to be paid back.
7. **Private Developer:** In large-scale urban development, a private developer can be required to undertake some social development in exchange for being allowed to participate in the scheme. This arrangement is sometimes called Development Finance or Concession contracts. The most eligible facility for concession contracts is Telecommunication and Energy, because potential profitability is high in this sector and therefore private investment in this sector is easy to syndicate. Build, Operate and Transfer (BOT) as one method of such arrangement, is a concept of development where private sector is given a concession of sponsoring and subsequently operating a certain project (usually infrastructure projects) which traditionally is the domain of government at their own cost. The project is then transferred to the government after the concession period. The government then may decide whether to further extend the concession to the original promoter with some return to the government or may operate on its own. The BOT projects (concession contracts) have many variants. Some of these variants are:
    a. **Build, Operate and Transfer (BOT):** In this system, the title holder to the land will enter into an arrangement with the financier/developer who funds the project and the developer re-coups his/her expenses plus profit from the proceeds of the projects over an agreed period of time (time-frame) and then transferred the title and the facilities to the original title holder or land owner.
    b. **Build, Own and Operate (BOO):** In this arrangement, the facility is not handed over at all. It is common between foreign firms and the government.
    c. **Build, Own, Operate, Subsidize and Transfer (BOOST):** With this arrangement, the project is subsidized for an agreed time-frame and at

the expiration of the period, the foreign firm transfers the structure to the government.

Other acronyms used to describe concession contracts include:

d. **DBFOT:** Design, Build, Finance, Operate and Transfer
e. **FBOOT:** Finance, Build, Own, Operate and Transfer
f. **BOL:** Build, Operate and Lease
g. **DBOM:** Design, Build, Operate and Maintain
h. **BOD:** Build, Operate and Deliver
i. **BRT:** Build, Rent and Transfer
j. **BOOT:** Build, Own, Operate and Transfer
k. **BTO:** Build, Transfer and Transfer

PART II

PRINCIPLES OF CONSTRUCTION ECONOMICS

CONTENTS

CHAPTER SEVEN

SCOPE OF CONSTRUCTION ECONOMICS

7.1 Introduction

Construction economics is a branch of general economics. It consists of the application of the techniques and expertise of economics to a particular area of the construction industry. Economics in general is about the choice of the way in which scarce resources are and ought to be collected between all their possible uses. Construction economics is a small part of a larger subject of environmental resources. This is concerned with the study of man's need in connection with shelter depicting suitable and the appropriate condition in which to live. It seeks to ensure the efficient use of the available resources to the industry and increases the rate of growth of construction work in the most efficient manner. It includes the study of the following:

7.2 Client's Requirement

This involves the study of the client's wants and needs ensuring that the designing is kept within the available funds provided by the client. The client's fundamental needs can be summarised as follows.

1. The building must meet the client's requirements.
2. The building is available for occupation on the specified date for completion.
3. The final account is close to the budgeted estimate/tender figure.
4. The construction project can be maintained at a reasonable cost.

7.3 Environmental Impact of Construction

This considers the wider aspect associated with planning and the general amenities affected by the proposed new construction project.

7.4 The Relationship of Space and Shape

This evaluates the cost implications of design variables; it does not seek to limit the Architect's skill or aesthetic (beauty) appearance of the project, but merely to inform the Architect and the client of the influence of their designs on the overall cost.

7.5 The Assessment of Initial Cost

This factor seeks to establish an initial estimate that is sufficiently accurate for advice purposes and can be used for comparison purposes throughout the building process.

7.6 The Reasons for and Method of Controlling Cost

One of the client's main requirements in respect of any construction project is the assessment of its expected cost. The method used in controlling cost will vary depending on the type of project and the nature of the client. The method adopted should be reasonably accurate but flexible enough to suit the individual client's requirement.

7.7 The Estimation of the Life of the Building and Materials

The emphasis of the initial construction cost has moved to consider the overall life cycle costing. The spending of a little more initially can result in a considerable saving over the life span of the building.

CHAPTER EIGHT

COST IMPLICATION OF DESIGN VARIABLES

8.1 Introduction

This Lecture discusses the design variables and their cost implications. Design Variables are numbers whose values can be freely varied by the designer to define a designed object. Design Variables can also be seen as factors affecting cost of construction. In view of this, the factors affecting cost are outlined and discussed below.

8.2 Factors Affecting Cost

The factors affecting the cost of a building are:

1. Plan Shape
2. Size of Project
3. Perimeter/Floor Area Ratio
4. Storey Height
5. Total Height

8.2.1 Shape of a Building

The shape of a building has a significant effect on its cost. Generally, the simpler the shape the lower the unit cost of the building, and the more irregular the outline the higher the unit cost of the building. Cost studies have identified a number of reasons for this and they include:

1. The more irregular the outline of a building is, the higher the perimeter/floor area ratio and the higher the unit cost of the building.
2. Irregular outlines result in certain items of work becoming more complicated and thus additional costs are incurred. This work items that can increase costs due to irregular shapes are: Setting out, Excavation and earthwork, Drainage, Brickworks, Roofing, Internal division and running costs. These will be more expensive as irregular shapes are more complicated. The running costs of the complicated building may also be affected by such factors as provision of more windows for ventilation.

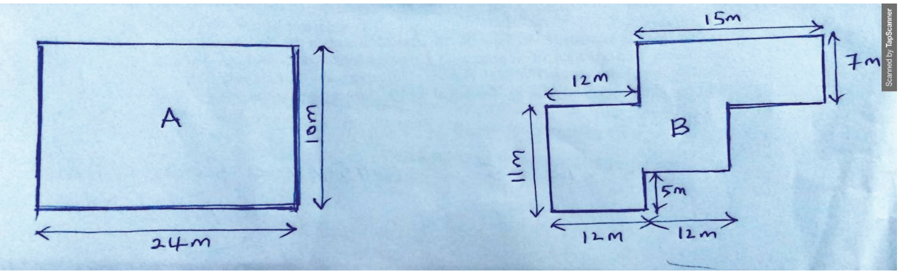


Fig. 8.1: Plans of a Regular (A) and an Irregular (B) Shape Buildings

Comparing the buildings in Figure 8.1, Building B has 60% more external wall to enclose the same floor area, setting out cost are increased by about 50% and excavation cost by about 20%. Blockwork and roofing will also be affected.

It is pertinent for the Quantity Surveyor to remember that cost is the only determinant of building shape. Having the building shape with the lowest cost may not provide the best design solution to give the client optimal value for his money. For example, circular buildings have the perimeter/floor area ratio that is high but are quite economical but result in major internal planning problems. In addition, the savings in the quantity of walls is offset by the extra cost of construction of circular walls over straight walls. It has been shown by past studies (e.g., Ikupolati, 2013; Ikupolati & Olaleye, 2016) that circular construction cost 20% to 30% more than straight construction of the same length. The simplest plan which is the square building is the most economical to construct but it has some peculiar problems such as:

1. Difficulties in planning and internal layout of the accommodation units.
2. Difficulty in providing natural day lighting to most part of the buildings.
3. Extra cost of providing artificial lighting to central part of square accommodations.
4. Additional cost of providing artificial ventilation to a central part of square accommodation.
5. Extra cost of providing more internal walls which will be load bearing.
6. Poor aesthetics.

8.2.2 Size of Project

Unit cost normally decreases with greater size of buildings. With a large project, prime costs and overheads are normally a smaller proportion of total cost than for the small projects. Some costs are almost fixed (especially the preliminaries) and as such are economical with the larger projects. Such costs are site offices, water supply, utilities of site, temporary roads, etc., will vary little with increase in the scope of the project. Also, in most cases, the large sized buildings have less wall/floor ratio as the partitions and their accessories are correspondingly reduced. Similarly, with high rise structure, the larger building has greater economy of lift and other equipment/services as same numbers may serve large floor areas than with smaller building. For instance, the total cost of a lift in an office does not significantly affect changes in the size, nor reduce the square meter price to a minimum. This also applies to a bathroom in a house, the same bathroom will serve a one-bedroom apartment house just as a two-bedroom apartment house. Therefore, the overall cost of a bathroom per square meter will be less in two-bedroom apartment than in one bedroom apartment. See Figure 8.2.

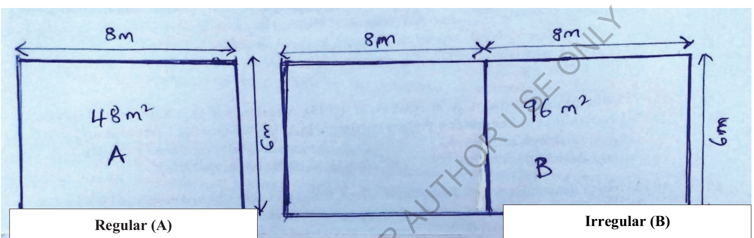


Fig. 8.2: Plans of a Single One-Bedroom (A) and an Undetached Twin One-Bedroom (B) Apartments

PLAN A

Perimeter = 28m

Wall Length/Floor Area = 28/48

Unit Cost (greater) = 0.58

PLAN B

Perimeter = 50m (including partition)

Wall Length/Floor Area = 50/96

Unit Cost (less) = 0.52

The wall length/floor area Figure 8.2(A) is 0.58, which is greater than that of Figure 8.2 (B) of 0.52 despite adding a partition wall.

8.2.3 Perimeter/Floor Area Ratio

This is also known as wall/floor area ratio. It involves dividing the perimeter of a building plan, taking as the area of the enclosing wall by the floor area. How economical a building is can then be determined from the value obtained. When calculating the ratio, the external wall area must include the windows and doors.

The lower the wall/floor area ratio, the more economical the proposal will be, but this may not be so in all cases, some other factors are to be considered. The wall/floor ratio is a means of expressing the planning efficiency of a building, and this is influenced by the plan shape and size. As discussed in Figures 8.1 and 8.2 under "size of building" factor, we can significantly reduce the cost of our buildings by reducing the ceiling height and doing so will reduce the overall area of the enclosing walls.

Total Wall Length = Numerator
Floor Area = Denominator

In principle, increase in the numerator in the above formula will increase the factor if floor area is constant and hence the cost of the building. Conversely, increase in the overall floor area enclosed (the denominator) will decrease the factor if wall area is constant and hence cost. An efficiently designed building which maximizes the floor area will reduce cost.

8.2.4 Storey Height

This is the height from finished floor to finished floor in storey building or from finished floor to ceiling or head room (bungalow). Variations in storey height do not affect the cost of the horizontal components of the building like the floors, roofs, but have a more or less direct bearing on the cost of vertical components such as walls, partitions and stanchions.

The vertical components of building of two storey or more can account for roughly ¼ to 1/3 of the total cost. Therefore, variation in storey heights affects to a reasonable extent the cost of a building.

Naturally, a greater storey height implies a greater cost although there may be exceptions like where the extra height is needed for some special functions like services, storage, etc., whose alternative provisions may be impracticable or too expensive. The element most affected by storey height variations are the walls (enclosing/partitions) and their accessories. Other effects of storey height increases include:

1. Increased volume for heating/cooling leading to a greater energy consumption and longer lengths of pipes and cables.
2. Longer service pipes for water supply and waste disposal.
3. Increased cost of vertical circulation means/facilities.
4. General increase in labour cost in ceilings, roofs etc. due to working at greater height.
5. Possible increase in cost of substructure to support increased wall loading.
6. Increased height and consequently cost of columns/stanchions for framed buildings.

8.2.5 Total Height

Constructional costs of buildings rise with increase in their height, but these additional costs can be partly offset by the better utilization of highly priced land and the reduced cost of external circulation works. Other effects of total height are:

1. Foundations cost/m^2 of floor area will fall with the increase in the number of storeys, provided the form of the foundation remains unchanged.
2. Beyond a certain number of storeys, the form of construction changes and unit costs usually rise. The change from load-bearing walls to framed construction is often introduced when building exceeds four storeys in height.
3. The effect of the number of storeys on cost varies with the type, form and construction method of the building.
4. As a general rule, maintenance costs rise with an increasing number of storeys, as maintenance work becomes more costly at higher levels.
5. Air conditioning costs are likely to fall as the number of storeys increases and the proportion of roof area to walls reduces.
6. Fire protection requirements increase with height as firefighting equipment becomes more sophisticated, involving the use of wet or dry risers and possibly sprinklers.
7. As the number of storey increases, both the structural components and circulation areas tend to occupy more space and the net floor area assumes a smaller proportion of the gross floor area, thus resulting into a higher cost per square metre of usable floor area.
8. Means of vertical circulation in the form of lifts and staircases tend to be increasingly expensive with high buildings, although fairly sharp increases in costs are likely to occur as the building gets higher.

9. Fees of specialist Engineers will probably be incurred for the design of foundations and frame, mechanical and electrical services and firefighting equipment.

CHAPTER NINE

EFFECT OF BUILDING USE ON CONSTRUCTION COST

9.1 Introduction

This chapter sheds light into the concept of the effects of residential buildings, industrial buildings, shops, schools, offices, and cost implication of specification on building components. Effect of building use on construction cost refers to the value of a building based on factors such as location, height of building, type of building and type of finishes.

9.2 Residential Buildings

The relative cost of low-rise and high-rise residential buildings were compared and reasons were sought for the much higher cost of the high-rise development over two-storey housing. The more intensive use of highly priced land will offset to some extent the increased costs resulting from multi-storey development. In addition, there may be social benefits to be gained. Some occupiers through this have closer access to town center and places of work although these benefits are difficult to evaluate, and there is ample evidence of sociological problems. High rise flats often cost between sixty and eighty percent more per square metre of floor area than houses with single storey. Cost influenced particularly by the cost of the frame and floors accounting for just over half of the increased cost and the cost of services including lifts taking up most of the remainder.

With single storey buildings, the main sources of higher cost in this type of flats as compared with a house is in finishes such as floors, landing, staircases and balconies. These costs could be as much as two to three times greater than corresponding items in two-storey housing, while the majority of other components average from twenty to seventy percent higher in cost, savings in roof and substructure cost were not particularly significant.

9.3 Industrial Buildings

Authors have opined that Industrialists have a general preference for single storey premises but a variety of matters such as limitation on land available and increased demand for car parking space may justify re-appraisal. A wide diversity of loading (of various manufactured or produced goods) occurs in factory buildings. The loads to be carried may affect the choice of site, influence the building design and if very heavy, may have a considerable bearing on the choice between single and multi-storey construction.

Post war industrial development included some muti-storey factories but the majority has been single storey. In the new and expanding town, almost all the factory buildings a single storey although possibly fronted with double storey office blocks. The 1980s saw a significant demand for warehouse but the recession in the early 1900s severely affected manufacturing industry and resulted in a sharp decline in the numbers of new factories under construction. Demand of small units of construction was high, and they were subject to frequent change of ownership. This is more beneficial to building owners as compared with larger industrial buildings.

The design of factories is primarily concerned with two aspects: space requirements of the occupier and structural requirements. Most large industrial companies employ production and plant engineers who are capable of arranging plants and human, and make ample arrangement for parking and waiting space for long vehicles. Most factories are roofed in such a way that allows roof lights by use of transparent sheets.

The surface finish of the roof will depend on the type of work to be undertaken in the factory as some machinery might be attached to the roof. Span and space play an important role in design cost. The fewer the intermediate upright the better, but care must be taken to obtain optimum acceptable column positioning which will determine the structural grid. The fewer the column position, the greater the load concentration on a smaller number of points. Reconciliation is also needed between the number of columns required to keep the cost down and the number that will interfere with the production work in the factory. The factory floors take substantial load, except in small or ancillary buildings. The external walls are unlikely to be load bearing. The type of external walling will also have a significant effect on the thermal and sound insulation provision.

9.4 Shops

The number of storey incorporated into other types of buildings will often be influenced by the purpose for which the building is to be used and/or the value of the site. Shops are generally of single storey construction for the convenience of users while offices are often multi-storey to make more intensive use of highly priced central sites and to enable the occupants to be as far removed as possible from traffic noise. An ideal approach is to build offices on top of shops in the center of large towns and cities, and flats or maisonnettes above shops in neighbourhood centers. Flexibility should be the prerequisite of every shopping complex based on the optimum structural grid.

9.5 School Buildings

School buildings are of varying heights but predominantly single storey buildings amongst primary schools. Secondary schools are often of two, three or four storey and technical colleges and colleges of further education are often of several storey except for single storey workshops and laboratories. Past studies have shown that a two-storey building was the cheapest proposition and that both three and four storey buildings were significantly cheaper than a single storey building (Ikupolati, 2013; Ikupolati & Olaleye, 2016). The factors that contribute to the higher cost of single storey buildings include the greater quantity of work below ground floor level and in roof and drainage work. More external doors which are relatively expensive and more pipe and cable run add to the cost. The unit cost of three and four storey blocks exceeded those of two storey blocks with the same total floor area for several reasons such as roofs and work below ground level, the reduction in cost/square metre obtained between the single storey buildings diminish as the floor area increases with the provision of additional storey. The three and four storey buildings must be provided with two staircases whereas one is sufficient for the two-storey building. As the height of the building increases there is increase in the need for wind bracing.

9.6 Office Buildings

Tenant's requirements are an important aspect of the office development process. Developers must generally prepare to provide good quality office buildings with high standard finishes and services. Higher rent demand higher standards. Tenants are basically looking for good simple and reliable services and an attractive approach to the offices, a good entrance hall and flexibility in the use of the space which they are renting. The spacing of columns across the width of the building will need determining at an early stage. A general arrangement is two rows of columns forming a corridor down the center of the building. This arrangement is flexible to be used either for individual cubical offices or if the whole floor is left open for a single department. It is necessary to establish an economic structural grid for column spacing otherwise the structural cost will be expensive in relation to overall building cost. Technically, it is possible to keep the floors completely free of columns to provide maximum flexibility but the cost of achieving this is usually great in relation to the potential advantage. An office shell may have a life span of 60 – 100 years but the tenant could change every 10 – 15 years and internal office landscape every one to three years. Office strips are connected by nodes, lift, and stairs.

9.7 Cost Implications of Specification on Building Components

Specifications are written documents that describe the quality of materials and workmanship required for a development. The components include walls, roof, floors, doors and windows, finishes and service installations.

9.7.1 Walling

Walls and partitions with associated doors and windows constitute a major item of expenditure of a building. The curtain wall, the most common type of non-load bearing wall, may be assembled either on or off the site. It consists of an exterior skin backed with insulation; a vapour barrier; sound-deadening materials; and an interior skin that may be part of the curtain wall or may be attached separately. The exterior skin may be made of metal (stainless steel, aluminium, and bronze), masonry (concrete, brick, and tile), or glass, Limestone, marble, granite, and precast concrete panels are also used for facades. The traditional method of constructing a roof is to lay roofing sheets over steel or wooden roof truss or laying of felt or tar on concrete roof.

9.7.2 Roof

The majority of multi-storey flats have flat roofs. The need for lift motor rooms, tank rooms ventilating plant, when necessary, add to the complexity of roofs. Savings that would have been made by using a roof to cover a number of buildings is offset by the added cost of construction. Building ancillary structures on roof is both expensive and often aesthetically unsatisfactory. Asphalt is the most common covering to flat roof.

9.7.2.1 Roof finishes

The range of roof finishes available is immense. Among materials available are aluminium, zinc, clay, slate, concrete, metal, timber, synthetic or a combination of various types. The main factors to be considered in the selection of finishes are:

1. The provision of an impregnable skin which does not change is characteristics on exposure.
2. Low cost and ease of maintenance and repair.
3. Speed and ease of application.
4. Long life expectance.
5. Ready availability
6. Suitable visual qualities such as colour texture, scale and applicability to the required roof form.

In Nigeria, aluminium/zinc account for 90% of pitched roof coverings, because they are economical and technically suitable. For flat roofs, there is no such clear-cut market situation and the factors influencing choice are frequently more oriented towards the specialist skills of laying.

9.7.2.2 Roofing costs

An estimated roofing cost based on drawing is prepared based on price list obtained from sub-contractors. Accurate roofing cost is prepared based on quotations received from sub-contractors.

9.7.3 Flooring

Floors and floor coverings, from the basic components of a building. When the first dwellings for protection and shelter were built, the ground served as the floor; branches, reeds, and wood logs were among the early materials also used as floors and floor coverings. Stone and brick floors appeared with the first stone building constructions during the 4th millennium. The ancient Greeks made extensive use of stone and marble, and Romans used concrete; especially as a base for mosaic floors. In early times, floors became an important ornamental element in Architecture. Mosaic, coloured and glazed tiles, marbles of different colours, and inlaid woods have been used throughout history to create designs.

Tile floors appeared in European cathedrals during the 12th century. Terrazzo flooring consisting of small marble and granite chips embedded in cement became popular during the renaissance and is still used nowadays. A wide variety of materials are used in modern floors. Concrete and wooden floors are usually covered with carpets, rugs, and other floorings for aesthetic reasons and to increase durability of the surface, absorption of sound, and ease of maintenance. Tiles also play an important role in modern buildings and homes. Of all floor coverings, tiles are the most resistant to water and humidity, and they are easy to clean. Glazed ceramic tiles are used whenever high sanitary conditions are required, such as in hospitals, laboratories, swimming pools, and public rest rooms. Synthetic, resilient floorings include linoleum, asphalt tiles, vinyl asbestos and pure vinyl tiles, and rubber. Floor finishes also vary considerably in unit costs. The thickness of the flooring can influence structural costs as thick finishes like wood blocks may produce a taller building than a thinner floor covering such as vinyl tiles spreading on the screed thickness. Cleaning and maintenance costs of floor finishes are other important considerations which should be taken into account in any cost appraisal.

A number of natural and synthetic materials are used as floor coverings. Each offers a range of advantages and disadvantages in terms of durability, comfort, ease of cleaning, and ability take colours or form attractive designs. Wood flooring has been used for centuries and still accounts for a large percentage of floors. In the United States, oak flooring is the most common because of its fairly high resistance to wear. Most wood floors are laid as planks, or strips, or a parquet tiles. Although they are attractive, wood floors need more care than do most other floors.

Cork, treated with heat or linseed oil and sometimes coated with vinyl, can be used as tiles or carpeting. Its ability to absorb sound is excellent, but its wear properties are inferior to those of other floor types. Kitchens, bathrooms, and entry areas, especially, often have floors of terrazzo or ceramic or quarry tile. These floors are very hard, waterproof, and strain-resistant.

9.7.4 Doors and Windows

Window is an opening, usually framed with wood or metal, built into a wall or roof. Windows are usually constructed with glass to admit light. There is a wide range of choices available from timber to steel, aluminium to metal. There can be wide variation in price according to the particular design of the window and the number of opening lights. For instance, with 1200 x 1100mm steel windows, the introduction of two opening lights over and above a single fixed light can increase the total cost of the window by 25%. Until the 1970s, the use of stainless-steel windows was confined almost entirely to banks, insurance offices and large department stores on account of their high initial cost.

9.7.5 Finishes

The range of choices available for wall and ceiling finishings is probably greater than for any other components of a building and the choice is influenced considerably by the class and use of the building. In municipal housing, finishing to walls and ceilings can account for up to 10 – 14% of the total construction costs in varying situations. There are very large regional differences in the cost of internal decorations. In industrial buildings, clients are generally not prepared to spend more than 4 – 6% of the total construction cost on internal finishes with the majority allocated to floor finishes, the specification being influenced mainly by the function and profit.

The use of plaster board and similar sheet materials to form a dry lining to dwellings has become increasingly popular as it simplifies the work of the finishing trades and leads to earlier completion. Decorative lamination offers a number of advantages which include: uniform coverage of large areas, attractive appearance, good durability and good resistance to wear biological and chemical attack, heat and moisture and low maintenance cost. They are particularly well suited for use in the communal parts of buildings where an attractive hardwearing and low maintenance cost surfacing is desirable.

The acoustic properties of finishes are becoming increasingly important. Acoustic materials are manufactured in three major categories: Porous materials for general sound absorption but with special reference to high frequencies; resonant panels for absorption at low frequencies; and Cavity resonators which can be designed to provide maximum absorption at a particular frequency.

Ceiling is the overhead surface of a room, opposite the floor. Usually, the term refers to a flat, beamed, or curved surface that conceals the underside of the roof or the floor above, but it may also refer, generally to the exposed underside.

9.7.6 Service Installations

Buildings and their environmental services have become more complex and the range of choices continue to increase. Unfortunately, the wide choice, lack of experience of new techniques and the need for assistance from more specialist skills have tended to act as constraints. Design now involved maintenance. This is unfortunate when viewed against the high cost of service installations which may amount to as much as 25% on housing schemes.

Plumbing, system of piping that carries water into and out of a building, protect public health. Every inhabited building must have a supply of safe water for drinking and for the operation of the plumbing fixtures and appliances, and a sanitary drainage system of wastewater disposal. To provide the sanitary facilities required, local government authorities are responsible for establishing regulations known as plumbing codes, which govern design and installation requirements and the minimum number of fixtures needed, based on building use and the number of occupants.

9.8 Water Supply and Drainage Installations

In developed communities, water under pressure is secured from street water mains and piped into the buildings. In other areas, water must be obtained from on-site wells or adjacent streams or rivers, in which case great care must be taken to ensure that the water is purified. Where available street pressure is insufficient to serve a building because of its height, equipment within the building, such as a pump that supplies a gravity tank above the roof or a booster pumping system must be installed. In hospitals and laboratories, special water system such as distilled, dematerialized (deionizer), and reverse osmosis (RO) water system are usually required.

Drainage systems are of two basic types: Sanitary and Storm Water. Sanitary drainage systems carry bodily and other wastes from the plumbing fixtures and appliances by gravity through a sewer to a sewage treatment facility outside the building. Sanitary drainage piping inside the building must be linked to a system of vent piping, to keep the pressures in all sections of the drainage piping equal.

Storm-water drainage systems carry rainwater from the roof by gravity through a sewer to a body of water or to a dry well (an area of the ground where waste water can drain into the surrounding soil). Basement drainage usually needs to be collected in a sealed and vented pit or tank and pumped out of the basement. Hospitals and laboratories often require additional special drainage systems for removal of acid waste, radioactive waste, and infectious waste.

Sewage disposal. Or wastewater disposal, treatment, and sanitary disposal of liquid and wastewater from households and industrial plants. The issue of sewage disposal assumed increasing importance in the early 1970s as a result of the general concern expressed in the United States and worldwide about the wider problem of pollution of the human environment, the contamination of the atmosphere, rivers, lakes, oceans, and groundwater by domestic, municipal, agricultural, and industrial waste.

9.9 Heating, Ventilating and Airconditioning

These related processes are designed to regulate ambient conditions within buildings for comfort or for industrial purposes. Heating an area raises temperature in a given space to a more satisfactory level than that of the atmosphere. Ventilation, either separately or combined with the heating or air-conditioning system, controls both the supply and exhaust of air within given areas in order to provide sufficient oxygen to the occupants and to eliminate odours. Air-conditioning designates control of the indoor environment year-round to create and maintain desirable temperature, humidity, air circulation, and purity for the occupants of that space or for the industrial materials that are handled or stored there.

9.10 Fire Fighting

This is the technique and equipment used to extinguish fires and limit the damage caused by them. It consists of removing one or more of the three elements essential to combustion, fuel, heat, and oxygen or of interrupting the combustion chain reaction.

9.11 External Works

This can be broken down into site preparation, retaining walls, screen walls and fencing, paved areas, drainage, external services, and landscaping. External works from a significant part of total building costs and justify taking steps to reduce cost by reducing the amount of earthwork and retaining walls, restricting paved areas to a minimum, reducing pipe runs of drains and other services and seeking materials and components which perform their functions satisfactorily and at the same time show favourable costs-in-use figures.

PART III

CONCEPT OF DEVELOPMENT ECONOMICS

CONTENTS

CHAPTER TEN

AIMS OF PUBLIC AND PRIVATE DEVELOPERS

10.1 Introduction

Development Economics is a branch of Economics which deals with the economics aspect of the development process. Its focus is not only on methods of promoting economic growth and structural change but also on improving the potential for the mass of the population, for example, through health and education and workplace conditions, whether through public or private channels. Development economics involves the creation of theories and methods that aid in the determination of policies and practices and can be implemented at either the domestic or international level. This may involve restructuring market incentives or using mathematical methods like inter-temporal optimization for project analysis, or it may involve a mixture of quantitative and qualitative methods. Unlike in many other fields of economics, approaches in development economics may incorporate social and political factors to devise particular plans. Also, unlike many other fields of economics, there is "no consensus" on what students should know. Different approaches may consider the factors that contribute to economic convergence or non-convergence across households, regions, and countries. The development of the construction industry embracing building works and civil engineering works and; associated mechanical and electrical services started by a gradual process of differential fragmentation. Previously the relationship between the procurer and the producer was simple and straight forward. However, as the requirement became more complex through technological innovation and increased expectations, the production process began and management-oriented disciplines.

Over the years the most recurrent word in writings and speeches made about physical development is ‘economy’. In this perspective therefore, development economics can be defined as the study of the forces affecting the uses of assets and resources in satisfying man’s need for shelter and a properly managed environment. To enhance this perception, there is need to carry out cost research with the purpose of investigating overall building and infrastructural costs and their interrelationship, including maintenance and running costs. Cost study involves the breaking down of total cost so as to:

i. Reveal the distribution of costs between the various parts of the building.
ii. Relate the cost of different parts or elements to the entire structure.
iii. Compare the costs of functional part or element in different structures.
iv. Establish a proper balance of quantity and quality within a predetermined cost limit and targets.
v. Establish a data base or data bank for the purpose of planning for future buildings and services.

10.2 AIMS OF DEVELOPERS

Every development, be it for a public authority, industrialist or private investor, has a market value – a potential worth or earning power. Even civic buildings, hospitals, churches and universities have an assessable value to the community – a cost above which it is not reasonable or feasible to build.

The art of phasing development to give an early return which can be used to pay for the less remunerative items is one of the objectives of a skillful developer. In this connection, an amalgamation of public and private agencies in development can be of great benefit to the community. Another factor is time. Time is also important in the planning process; for maximum economy the time between capital expenditure and completion of a project should be kept to a minimum.

The private developer or industrialist will require a financial appraisal or feasibility study to determine the likely capital expenditure and probable revenue in order to arrive at the anticipated return on the money invested. It is, therefore, necessary for the developer (whether public or private) to know the nature and extent of the proposed development, its cost and time required to complete it.

From the above the main aim of a developer is to get is development project executed or completed within the minimum time, minimum cost and maximum quality so that early return could be achieved, either in terms of monetary benefit (private developer) or non-monetary benefit (public developer).

10.3 CONSTRAINTS FACED BY DEVELOPERS

Developers may suffer loss for a number of reasons out of which the major ones are:

i. Payment of an exorbitant price for the land.

ii. Unexpected capital expenditure stemming from such matters as problems with underground services or contaminated land, extra cost of work needed to satisfy building regulations or town planning requirements, or to comply with easements or restrictive covenants.
iii. Unattractive layouts or provision of dwellings of types for which demand is limited, resulting in selling problems.
iv. Organisational weaknesses, such as inadequate or ineffective advertising, poor supervision and execution of work in the wrong sequence.
v. Problem of proper decision making as to whether to purchase a building or lease it.

CHAPTER ELEVEN

FACTORS INFLUENCING DEVELOPMENT PROCESS

11.1 Introduction

A development is defined in Town and Country Planning Act 1990 as 'the carrying out of building, engineering, mining or other operations in, on, over or under land, or the making of any material change in the use of any buildings or other land. Legally persons hold interests in land but do not own it, because all land is held from the Crown on tenure. Nevertheless, a freeholder with a freehold interest in the land is the absolute owner of the property in perpetuity, and he can do as he likes with it, provided he does not contravene the law of the land or interfere with the right of others.

A freeholder can create a lesser interest out of his absolute one, such as leasehold interest for a limited period and subject to the payment of rent. The landlord or lessor retains an interest in the land, known as a reversion, and is entitled to receive the agreed rent. The tenant or lessee has exclusive possession of the property for the period of lease. As a general rule the lessee can assign or sell his interest to another person or grant a sublease for a shorter term than his own lease.

The Leasehold Reform Act 1967 permits certain tenants to purchase the freehold of the property which they occupy. With a building lease the lessee pays a ground rent for the land and undertakes to erect and maintain suitable buildings on the land. For the period of the lease, often ninety-nine years, the lessee receives an income from this possession of the buildings and land but on the termination of the lease, both buildings and land revert to the freeholder.

11.2 Factors Influencing Development

There is a wide range of factors influencing the development of a building site, from the physical characteristics of the site itself to legal restrictions, planning controls and building regulations.

11.3 Site Characteristics

Each site has its own characteristics, which have an important influence on its suitability for development for a particular purpose. The main characteristics here are:

1. **Soil Conditions:** The subsoil of a site/land should have a reasonable load-bearing capacity, because poor soils create foundation problems and increase constructional costs.
2. **Ground Water:** It is desirable that the site should be well above the highest ground-water level and free from the possibility of flooding. Working on wet conditions is difficult and a permanently wet site can give rise to unhealthy conditions for occupants, and deterioration of the buildings.
3. **Contours:** A reasonably level site will reduce constructional costs particularly where the building cover large areas as with factories. Steeply sloping sites require stepped foundations and extensive earthworks, and may involve special land drainage installations as well as being inconvenient to users of the site.
4. **Contamination:** Landfill and former industrial sites are best avoided because they can involve expensive site works to remove potential hazards.
5. **Obstructions:** These may take various forms and all involve additional expenditure in site clearance work.
6. **Services:** The availability of essential services, such as sewers, water mains, electricity cables, telecommunications and possibly gas mains, of adequate capacity, is an important consideration.
7. **Access:** Satisfactory access to the site must be available and some types of development will require good access roads leading to the site, with adequate sight lines at the junction with an existing road.
8. **Aspect:** Ideally the site should be on a gentle slope facing in a southerly direction to secure maximum sunlight and protection from the cold northerly and easterly winds. In practice the ideal site is rarely obtainable.
9. **Site Boundaries:** The type of condition of site boundaries and their ownership needs identifying, together with the evaluation of any constructional problems likely to arise from buildings adjoining the site as the project progresses.
10. **Area of Site:** There needs to be adequate space available on the site for the storage of plant and materials, the erection of temporary buildings and sufficient workspace.

11.4 Planning Control

Planning controls stem from the operation of the Town and Country Planning Act 1990, and were administered principally by the county councils and district councils, termed local planning authorities, with the county planning authorities preparing structure plans and district planning authorities formulating local plans, unless reserved to the county planning authority and dealing directly with many matters of planning control. These authorities uphold laws which determines what, where, when and how a developer should build.

11.5 Building Regulations

Building regulations which affect the development of land are employed in the following areas:

11.5.1 Buildings of Special Interest

These are a list of buildings of special architectural or historic interest compiled by the Department of the Environment. These buildings cannot be demolished, extended or altered so as to affect their character without obtaining a listed building consent from the local planning authority. The only exceptions are where the works are urgently needed for the safety or health of persons or the preservation of the building. Breach of these requirements or conditions prescribed in consent constitute a criminal offence. There is provision for *enforcement notices*, requiring the owner or occupier to restore the property to its former state, and for *purchase notices* whereby the owner requires the local planning authority to purchase his interest in the property because the listed building has in its present state become incapable of reasonably beneficial use. It will be appreciated that a listed building can constitute a major obstacle in a development scheme.

11.5.2 Tree Preservation Orders

Under the Town and Country Planning Act 1990, a local planning authority is empowered to make a tree preservation order for the preservation of a single tree, groups of trees or woodlands in the interests of amenity. Such an order prohibits the felling, lopping, uprooting, willful damage or willful destruction of specified trees, groups of trees or woodland without consent and may also require the replanting of woodlands felled in the course of forestry operations. Tree preservation orders can therefore operate to the disadvantage of a developer in that they may restrict the form and extent of the development.

11.5.3 Conservation Areas

Under the Planning (Listed Buildings and Conservation Areas) Acts 1990, it is the duty of the local planning authority to determine from time-to-time which parts of their area should be treated as conservation areas, on account of their special architectural or historic interest, character or appearance, which it is desirable to preserve or enhance. The local planning authority prepares a conservation area plan and, upon designation, special procedures operate for applications for planning permission, control of demolition of buildings and felling of trees, and possible stricter controls over outside advertising. This can also constitute a major obstacle in a development scheme.

CHAPTER TWELVE

BUDGETING FOR PUBLIC AND PRIVATE EFFECTS ON DEVELOPMENT

12.1 Introduction

Every development whether it be for a public authority, industrialist or private investor, has a 'market value' – a potential worth or earning power. Even civic buildings, hospitals, churches and universities have an assessable value to the community – a cost above which it is not reasonable or feasible to build.

12.2 Public Finance

Central government funds are obtained from two main sources: internal and external. Internal sources are mainly confined to nationalized industries where internal cash flows provide a source of finance for the industry's investment; external sources of finance are taxes and borrowing.

In the case of local authorities, money may be obtained by grant from central government funds or may be raised by the local authority's own borrowing or local taxation. In general, local authorities meet current expenses out of local taxation and this may be augmented by the profits of successful local authority enterprise. Housing associations receive grants from central government through the Housing Corporation and loans from clearing banks, building societies, merchant banks and insurance companies.

12.3 Developer's Returns

The majority of building clients are seeking a financial return on the capital they invest in building projects. Nevertheless, there are some projects which are of a semi-commercial nature like local authority housing and others which are non-commercial such as schools and churches. With the latter category of project, the economic return approach will be difficult to apply and local authority housing falls between the other two classes of project with its complex political and social implications. From the quantity surveyor's point of view, it is important that the developer, in whatever category he may fall, shall prescribe the upper limit of his budget at the outset, in order that the quantity surveyor may formulate a cost plan with the object of securing value for the money expended and a realistic and advantageous distribution of costs throughout the various parts of the building. The general procedure and problems associated with budgeting for each category of development are now considered below.

12.4 Budgeting for Commercial Properties

The major financial houses have come to recognise that property; particularly commercial and industrial property has a good investment value and generally compares favourably with other investment opportunities. Investors often require, as part of the consideration for lending, a share in the profits. This has resulted in the investor showing a very real concern in the situation, design and profitability of the building. Projects must be well-conceived and efficiently executed; built to designs which are attractive satisfy the local planning authorities and meet the needs of occupants, as well as being profitable.

Modern good quality office and shop developments have, despite the problems in the 1990-1993 recessions, generally been reasonably good demand for investment purposes, particularly from insurance companies and pension fund. Industrial and warehouse properties have become more acceptable, although requiring a higher return, although there was a substantial over-provision in the early 1990s.

Financial institutions like to maintain a balance in their property portfolio between shop, office and industrial premises, including business parks and retail warehousing, but whatever type of property in considered, certain factors have to be taken into account. These factors include the return on capital invested both now and, in the future, the financial security afforded by the tenant, the quality of the location and its future prospects, terms of lease and liability for insurance and repairs.

12.4.1 Offices

A common type of commercial development project is a block of offices where the developer needs to be assured of a reasonable excess of income over expenditure. He will be laying out a substantial capital sum now in anticipation of a larger return later. The capital outlay will be for site and buildings and the return is often in the form of rents. It would be quite absurd to spend a large sum of money on a site for a proposed office block unless and until an expert financial appraisal has been carried out indicating the overall supply/demand situation and rent levels for offices in the area. This appraisal would include consideration of many related aspects, such as growth of commerce in the area, demand for all types of office space, site characteristics, transport facilities, public utility services and associated services, such as banks and financial institutions.

The rent level is influenced considerably by the quality of the accommodation, so the standard of quality must be determined at an early stage. The amount of space to be provided will depend on a number of factors, including estimated demand, site area, planning restrictions and rights of adjoining owners. The site value can be determined by the residual method, whereby building costs and developer's profit are deducted from the gross development value. The quantity surveyor will prepare estimates of building costs based on the architect's preliminary designs and the standard of building needed to attract the rents set by the Valuer. It is vital that the quantity surveyor's estimate is realistic; otherwise, the developer may have difficulty in obtaining his desired profit margin.

12.4.2 Shops

The complexities surrounding schemes of large-scale commercial development may not be generally appreciated. Developers must ascertain the requirements of the large space users and in many cases a large measure of pre-letting is necessary so that the development is planned around them. Furthermore, the scheme is likely to take several years to complete. Even after securing anchor covenants, because of ever-rising costs and retailer's lack of capital for expensive shopfitting, it takes time and knowhow to let all the remaining shops, with a certain loss of interest on capital in the meantime. More existing shopping streets will be pedestrianized and most modern shopping provision is in fully covered air-conditioned shopping centres, involving developers in management and promotion activities.

Apart from yield rate, inflation has caused developers and their advisers to consider future growth and the need for periodic rent reviews. Unlike offices, shop tenants of good standing have to invest capital on shop fitting and resist earlier rent reviews than seven years, as it takes time for a new branch to achieve full earning capacity. The large space users whose covenants are sought after often hold out for a fourteen-year review period, particularly if their existing branch already forms part of the development site and rehousing is necessary. This sometimes causes difficulties in obtaining finance, and there is merit in adopting a basic minimum rent plus a percentage rent based on turnover to eliminate rent reviews. Where developers collaborate with local authorities in partnership arrangements for the redevelopment of central areas, it is essential that the developers should receive an adequate share of the return, commensurate with the work, expertise and risks involved.

12.4.3 Factories

Much of the present factory and warehouse provision is outdate and ill-suit for today's needs, whilst some of the newly erected factories are sited in unsatisfactory situation, sometimes as a result of government policies and local authority action. Industrial buildings let at lower rent than other property and gain higher yields (10-11 per cent in 1993) because of the greater risk to investors.

The Government provides a variety of incentives to industrialists who move to one of the areas for expansion in Great Britain, and those who expand or modernize an existing operation within one of these areas. These are available under the Industry Act 1972 and the employment Act 1972. There is also provision for tax allowances on new industrial buildings and structure (first year allowance of 4 per cent and writing down allowance of 4 per cent) and for plant machinery (first year allowance of 100 per cent).

The financial implication of an industrialist moving from old unsuitable premises to a new factory on an industrial estate can be conveniently considered under the following three headings:

(1) The provision of a new factory, complete with equipment and fittings;
(2) Removal expenses and dislocation of trade;
(3) Settling in period, training new staff and related matters.

12.4.4 Retail Warehousing

Retail warehouses need to be located on suitable sites on main roads, in strategic locations with a suitable catchment area, and be easily accessible to the car-borne shoppers. Growth across the retail warehouse sector has traditionally been developer led and must therefore be investors backed.

Retail warehousing showed considerable resilience during the recession of 1990-92, but by 1993 demand was rising particularly in the ranges of 900 to 2300m^2 and 6500m^2 upwards. The re-emergence of investors during 1993 restarted the development cycle bringing in new space. Yields below nine per cent were beginning to appear on developers' appraisals, although good, pre-funded, pre-let developments heavily outweigh speculative projects.

12.4.5 Business and Science Parks

There are almost as many definitions of business parks as there are schemes. They vary from two or three offices with a few flower beds to a development of 100000m^2 (10 ha), with a sophisticated infrastructure of roads, shops, restaurants, parking and landscaping. In the light of these a business park can be defined as a large tract of land, often in excess of 40 ha, developed in phases to a low-density offering occupier an attractive working environment and adequate parking provision capable of meeting the needs of a wide range of business sectors and functions. The most important factors were good locations and communications, prestige, environment and parking, but some lacked adequate public transport facilities.

12.4.6 'Privated' Housing:

The majority of owner-occupiers finance their house purchase by borrowing from building societies or banks. While most house-builders can arrange ninety or ninety-five per cent mortgages over a 25- or 30-year term on their new houses, they need to be aware of the financial standing and circumstances of the kind of purchaser they aim to attract to arrive at a viable price range; for the maximum advance a building society will make is usually limited to 2 ½ or 3 times the gross household income. For this reason, most speculative builders concentrate on low-cost houses. The private housing developer has no captive market, in the form of a housing list, on which to draw but has to sell each and every one of his houses to an individual purchaser.

12.5 Budgeting for Local Authority

A local authority has to balance income and expenditure relating to its housing provision but can do this in a number of different ways. The local authority has to determine the effect of each new housing scheme on its housing revenue account, and in the early nineteen nineties this way very much reduced as the local authorities' role changed from providers to enablers. The revenue side of the account will contain some or all of the following items:

1. Rents for dwellings received from tenants of houses;

2. Amounts paid in housing subsidies by the government;
3. Receipts from sales of houses; and

Contributions by the local authority out of local taxes.

The expenditure side of the account will largely be made up of:

1. Loan charges on money borrowed to finance the housing scheme (cost of site, demolition, clearance, compensation for distributed interests, building, buildings, site works, roads, sewers and other services, and professional fees);
2. Expenditure on housing management and administration;
3. Expenditure on repairs and maintenance, including renewals; and
4. Any other costs associated with housing, such as taxes and other charges.

12.6 Budgeting for Non-Commercial Projects

Preparation of development budgets for non-commercial projects, in the following areas, are very important

12.6.1 Schools

Probably the largest single group of non-commercial buildings are schools. It is not possible to produce a balance sheet of revenue and expenditure as there is no income received from local authority schools. It is therefore necessary to use some other criteria to establish cost standards and to ensure that local authorities receive value for money.

12.6.2 Hospitals

Time and cost overruns for hospital projects are commonplace with the various parties blaming each other for delays or late designs. Large hospitals are taking on average 10 years and often as much as 15 years from initial planning to commissioning, and clinicians' needs can change radically within a few years, as medical treatment advances and hospital administrators see faster patient throughput as the bottom line. Changes trigger conflicts as contractors' claims, leading to delay and spiraling cost overruns. To overcome these frequent problems, Fife Health Board opted to pioneer a fast-track design and build approach, comprising a firm policy with no design changes, thus firming up its hospital outturn price from the first day and to ensure a fixed completion date for the £32 million project. The Health

Board also took the rather unusual step of appointing its own project manager to oversee the scheme and an exceptionally detailed specification was prepared.

CHAPTER THIRTEEN

CONCEPT OF LAND VALUE AND DEVELOPMENT

13.1 Determinants of Development Value of Land

In commercial development, there is a very close relationship between how much the project will produce in revenue and its commercial values. In social development, this relationship may be expressed in cost benefit terms, by quantifying what are considered to be social benefit but the issue is never so clear cut and other criteria may be more important in assessing the amount that can be spent on the scheme.

Building development of any kind requires a plot of land on which it can take place, and which once used, will no longer be available for any other development, unless the first one is either demolished or converted. The development value of a piece of land is the difference between the cost of erecting or converting building on it and the market price of the finished development (including the land). Nobody can commission building operations on a piece of land unless they have interest in it, if possible, they would wish to own it, so as to obtain the full benefit of the development value of land, although in some areas where land is in very short supply, they may have to lease it. The development value of land will be determined by:

- **(i) Its Position:** That is both its geographical region and its local position in that region in regard to amenities such as communications, water, access road and market among others.
- **(ii) Restrictions on its use:** That is either imposed by the vendors in the form of covenant, or to the community in the form of planning restrictions. Planning schemes prepared by local planning authorities restrict the land that can be developed for residential purposes. Residential areas should desirably be conveniently located in relation to workplaces, shop, schools and other essential facilities.
- **(iii) Any “Easement” which goes with the Land:** Example is right of way across the land.
- **(iv) The Physical State of the Land:** Whether the land is level or very hilly, and whether there are buildings on it which need to be demolished.

(v) The Current State of the Economy

All the above factors influence the demand for the development of a land in any area or locality.

13.2 Choice and Acquisition of Site

Development has a pivotal concern with the environment, particularly with spatial relationships, including the provision and location of land uses and facilities, and the movement within them. The spatial pattern of a city in a free enterprise society is the collective result of a large number of separate business and household location decisions and transportation choices. Though there are several kinds of influences at work, essential land utilization takes place within physical institutional and economic framework as classified below:

a) Physical Framework refers to the laws of nature which would include geographical influence, climate, soil and topography.
b) Institutional Framework will include the practices, customs, traditional, laws, organisational and other institutions of human society which affect the property rights, the practices of financial institutions, such as banks and; of local government and public corporations are good examples of institutional framework.
c) Economic Framework will suggest the economies which are to be obtained from using a particular piece of land. Among these are; its accessibility to people, its location in relation to other pieces of land, its established use, its established potential channels of transportation or communication, which are the primary reasons for it being so used.

While the inputs of these frameworks are usually beyond the control of the decision maker, what is normally required is for him to comply with the standards and regulations. In the preparation and implementation of development plans, it is essential to comprehend the effect of the existence of these frameworks, and of the natural pattern and changes in land use that they are tending to produce so that they can be adapted as necessary.

The carrying out of survey of a particular area assists in the understanding of the tendencies in that area, and of the extent to which their fulfilment is desirable. For instance, in development appraisal, developers will consider which sites would be suitable for their purpose in a particular area. This is usually in physical characteristics, locations, relation to utilities (physical framework), and whether they would obtain the legal right to develop in the way they wish (institutional framework), and making bid, at prices related to the proposed use and for the right to develop (economic framework).

There are three principal methods of site or land acquisition available to the private developer: by private treaty or negotiation, by public or private auction, and by tender. The private treaty method is favoured by the majority of developers. Next in preference come public auctions and very much lower on the list is the tender system of acquisition. Public authorities also have powers of compulsory purchase.

13.3 Land Use and Value Determinants

Land is so unique in that each parcel or plot has a specific location with its own particular geography. Height above sea level, slope, latitude and longitude, soil and subsoil, rainfall, sunshine, temperature, wind exposure, drainage and distance from other places – all vary from one plot to another. Some of these variables can be partially controlled by the use of other resources – capital and labour for instance, but there is no homogeneity or easy interchangeability, each site has its own peculiar characteristics. Land development is the consequence of many decisions and implementing actions of both a public and private nature.

Value of land is specialist areas of Estate Surveyor, but anybody who is involved in cost planning of buildings needs to have some knowledge of the factors affecting the cost of land for development. Like the price of other commodities, the laws of demand and supply affect land values.

13.3.1 Land Use Planning and Urban Land Use

A universal interest has developed in land use planning and the determinants of the land use, and there is an increasing awareness of the advisability of forward planning. Town and country planning, or physical planning as it is more commonly described, is necessary to ensure that all development is coordinated with an eye to the future, and carried out in such a way to assist in producing a community environment that will advance human welfare in health, well-being and safety.

The World Health organisation defined planning objectives as a model of an intended future situation and a programme of action and predetermined co-ordination, illustrating the dynamic nature of the process and of the need to improve human conditions. It is possible to identify certain basic principles in land use planning – the unity of environment (fusion of town and country), comprehensiveness (controlling many activities often conflicting) and quality of the environment. However, planning authorities must accept that there is always a limit on the resources available and so they must actively encourage management and development – public and private – to accept and work for strategic goals.

Housing is easily the greatest urban land use which can account for as much as one half (or more) of the total urban area. Land use within an urban area can often be conveniently subdivided in to four separate and distinct districts or zones as given below:

1. **Central Business District (CBD):** This is the optimum location for many economic activities, such as shops, offices, theatres and hotels, having maximum accessibility.
2. **Zones of Transition Surrounding the CBD:** This is where older buildings are being replaced.
3. **Surburban Areas:** These are developed for residential purposes at moderate densities on cheaper land.
4. **Rural-urban Fringe:** These are areas that accommodate commuters who wish to live in rural surroundings**.**

In the 1980s – 90s this pattern was distorted to some extent by the development by out-of-town shopping centres, warehouses and business parks.

13.3.2 Land Value Determinants

While various users are in competition for sites, the sites vary considerably in their suitability for different purposes. The attributes of sites can be divided in to three main groups: physical, locational, and legal consents as to use. The prices of site are very much influenced by the use to which they can be put and can vary considerably over time. The following general model (Equation 13.1) for determination of land value is useful:

$$\text{Land Value} = \frac{\text{(Aggregate Gross Revenue)} - \text{(Total Expected Costs)}}{\text{Capitalization Rate}} \quad \text{------------------------ (13.1)}$$

Revenues are influenced by the investors' expectation of the size of the market, income spent for various urban services, urban areas' competitive pull, supply of competitive urban land and prospective investment in public improvements. Expected costs are the sum of local property taxes, operating costs, interest on capital and depreciation allowances. The capitalization rate is affected by interest rates, allowances for anticipated risk and expectations concerning capital gains. According to land economics theory, these factors are taken into account in the property market. Users of land bid for sites in accordance with what will maximize their profit and minimise their costs. Land users in retail business and services tend to bid for space at the highest prices, and land best suited for these activities shows the highest value. In a simple term, the value of land for development can be expressed as an equation as illustrated Equation 13.2.

Value of Development = Price of Undeveloped Land + Building Cost + Profit
--- (13.2)

As can be seen, the value of the development in a free market is its worth to the consumer (as compared to other alternatives), and this in turn largely fixes the price of the undeveloped land. The equation can therefore be better expressed as shown in Equation 13.3.

Price of Undeveloped Land = Value of Development – (Building Cost + Profit)
--- (13.3)

The most important factors influencing land values are:

1. **Supply and Demand:** A limited supply of building land, or fierce demand for it will force up the price.
2. **The permitted Use to which Land can be Put Under Planning Regulations:** Out of this central area uses such as shops, offices and theatres, are the most valuable.
3. **Location:** Highly priced land often being the most accessible.

4. **Physical Characteristics:** These affect the cost of development and suitability for a given purpose, industrial areas for example needing extensive flat sites.
5. **Availability of Public Services:** Examples are roads, sewers, water and gas mains, electricity cables and telecommunications.
6. **Form of Title (Freehold or Leasehold):** This also includes any restrictive covenants or other encumbrances which will affect its use.
7. General nature of the surrounding development and its compatibility.

CHAPTER FOURTEEN

BASIC CONCEPT OF FEASIBILITY STUDY

14.1 Nature of Feasibility Study

In the broadest sense, every rational decision to make new investment is preceded by an investigation of the economic feasibility of the project, whether or not this is carried out in a formal manner. The larger the project and the greater the investment, the more formalized will be the investigation. The investor will want to assure himself/herself that the market exists, or even developed, the raw materials can be obtained, that sufficient labour supply is available, that local services vital to the project can be assured, that the overall costs of plant, equipment, labour and raw material inputs will be of certain order. Most importantly, he/she will seek assurance that income will exceed costs by a margin sufficient to reinforce the inclination to undertake the project. On the other hand, if the project is small, the study format may be quite informal. Perhaps, there will be no formal study at all and little accumulation of actual data. Nonetheless, the feasibility calculation will have to be computed and reviewed by the investors before the ultimate step of actual investment is taken.

A feasibility study can serve a multitude of purpose, depending upon the point of view taken in the study. An individual will be interested in making a profit, financiers in project liquidity particularly in terms of repayment of loans; and government in benefits to the national economy, particularly in the framework of a coherent economic development programme. As such programme takes much of their physical form through the execution of individual projects, most governments with capital scarcity must allocate capital to projects in the manner in which will most effectively accomplish national objectives.

It is important to state that the format of feasibility study discussed in this Chapter is a suggested format, since no standard exists. Every feasibility study is different, tailored to the subject area as well as to the potential audience. However, the principle behind the exercise is similar. Therefore, in any given instance, one or more of the procedures highlighted in this Chapter may be omitted, due to special considerations.

14.2 Feasibility Analysis from Government and Private Viewpoints

A feasibility study which results in the determination of social profitability is one which has been conducted from the government's viewpoint. Such a feasibility study, which is frequently referred to as cost-benefit study, becomes necessary when profit fails to be a good measure of a project's contribution to the society. If the cost and prices used in calculating the profits do not accurately reflect the real costs to the society and their benefits, then adjustments must be made to correct the divergences between market prices and social values. Basically, the techniques involved in cost-benefit analysis entail procedures for making these adjustments to market prices. The difference in determining profitability in a feasibility study from the firm's viewpoint and the government's viewpoint is that the firm uses the price structure it faces in the market value while the government constructs an artificial price structure to use for project evaluation. These artificial prices are sometimes referred to as "shadow prices" or "accounting prices" and they depend to a certain extent on the objectives of the government. For example, in countries where peasant agriculture is important and underemployment is a problem, it is possible for the marginal product of labour to be less than the wage, which causes a distortion between the cost of labour and its price. The government, if employment is an objective, might use a "shadow rate" which would be lower than the actual market rate. Hence the cost of project, which involves the employment of labour would be lower and their social profitability would be higher than their commercial profitability.

14.3 Stages of Project Development

The development of a project undergoes a certain number of stages during which its various elements are prepared and examined in order to reach decisions. The preparation of a project therefore can be seen as a series of activities culminating in establishment of a certain number of studies and documents, which permit decision making. Projects are developed in a given institutional frame, which determines their nature and the number of economic agencies likely to be interested in them. Thus, the nature and sequence of decisions concerning viability of the project, its location and financing, etc., will be determined by various institutional policies. Also, the range and accuracy of information necessary for decision making in different stages of a project will depend on its inherent characteristics: size, degree of complexity, sector, type of final product, etc. Therefore, the attempt to describe a typical procedure for the preparation of an economic feasibility study is general because the decisions to be made and the information required will vary between institutions and types of products. The process of preparation and execution of a project, following the determination of the objective to be attained, can be divided into stages and steps. These steps have the following features:

14.3.1 Identification

The starting point of an industrial project is the setting of the objective to be attained, i.e., the belief that it is possible and desirable to manufacture a certain product or group of products, or to utilize certain resources. This belief can result from a survey of existing industrial establishments, sectoral or inter-industrial analysis, geological surveys, market studies, etc. It is often a response to a need that appeared within the framework of industrial development planning.

14.3.2 Pre-selection

A decision must be made as to whether it is advisable to conduct detailed economic feasibility study of the project, and if so, to define the scope of subsequent studies. This requires ensuring that:

a. The project is of sufficient interest on the technical economic plan to justify detailed study, i.e., a feasible solution can be anticipated.
b. The project conforms with the objectives of governmental strategy and plans.

The results obtained during this stage are compiled in a preliminary feasibility (pre-feasibility) study. Enquiries are conducted by the investor himself/herself or by a "fictious investor" (promoter); the latter can be a development body, ministry, etc. Once it has been ascertained that the project deserves study in detail, an investor must be found who is willing to carry it out (if promoter and investor are not one and the same). The pre-feasibility here is undertaken in order to determine:

a. Whether the objectives of the project conform with government policy;
b. Whether the project, at first sight, seems to justify detailed study, and estimated cost of study.
c. What aspects of the project deserve special attention during subsequent research (market surveys, laboratory tests, technical matters, etc.).

To permit decision on the merit of the project, the study must include: A description of the market (estimate of consumption, trends, present supply, price, etch,); An outline of technological variances and information concerning availability of main production factors (mainly raw materials); and An estimate of necessary investment, cost of operation and approximate estimate of profit.

14.3.3 Formulation

At this stage, the various alternative solutions (technical, economic and financial) must be studied and the conclusions and supporting data presented in a systematic form. This is achieved by partial studies (of techniques, markets, etc.) or complete studies (or economic feasibility).

14.3.4 Evaluation and Decision

A decision must be taken at this stage as to define its essential economic and technical characteristics. If an order of priorities exists, the project must be quantitatively assessed in terms of its ranking and priority. Although, formulation of the project already implies an assessment, the feasibility study and other preliminary investment studies, also must be evaluated by the investor or the body upon whose approval and execution of the project will depend.

14.4 Market Component of an Economic Feasibility Study

In the market section of a feasibility study, future demand for the product(s) should be assessed accurately as possible, at least for the expected amortization period. The study must include the following:

a. Analysis of past and present demand (consumption, in quantity and value, price trends, etc.).
b. Analysis of sources of supply (local production, main producers, cost trends, imports, distribution channels and marketing).
c. Estimate of future domestic demand (based on trend projections, analysis of end users and technical coefficient, international comparisons, expected elasticity in demand, etc.) and export possibilities (information on absorptive capacity of the market of some countries, trade agreements in existence or likely to be concluded, etc.).
d. Estimate of future production (projects in construction, projects in preparation, etc.).

e. Projection of trends in effective demand per year (domestic and export) and an estimate of the project's share in these markets.
f. Steps to take in order to ensure the forecast share of each market.

14.5 Technical Component of an Economic Feasibility Study

The technical section of a feasibility study should contain a review of techniques (processes) that could be applied. This study involves the following:

a. Description of applicable technological variants and condition for their implementation (site, raw materials, power, water, public utilities, labour and management, patents, etc.).
b. Study of availability of necessary production factors (physical and chemical properties of raw materials and possibility for using them in certain technological processes, availability of other essential factors, etc.) with indication, if necessary, of location of sources of supply.
c. Selection of technologically viable variants including the following: Main characteristics of the necessary equipment and machinery; Labour needs; Possible location; Forecast expense on equipment for each variant.

14.6 Site Study in an Economic Feasibility Study

The site study is needed to evaluate comparative advantages to the investor and the national economy of the suitable sites from a technical viewpoint, and to recommend the most appropriate location. The study comprises the following:

a. An estimate of the equipment expense and operation costs entailed in the selection of certain site (site acquisition and development, transportation of raw materials, fuel and finished products, water supply and sewage treatment, power supply, labour recruitment, etc.).
b. For every location, an assessment of costs and advantages for the national economy, costs, housing, expansion of tertiary sector, public services and environmental conservation.

14.7 Financial Component of an Economic Feasibility Study

The financial section of a feasibility study consists of an assembly of the market, technical and site data into a financial format so that the project's desirability can be evaluated. This study involves the following:

a. Preparation of an earnings estimate so that the project's commercial profitability can be evaluated.
b. Analysis of cost and benefits (i.e., social profitability) of the project, in terms of the national economy.
c. Preparation of cash flow estimates for years of construction operation before reaching the normal years.
d. Preparation of balance sheet estimates for the pertinent years.
e. Evaluation of the project's suitability from a financial viewpoint.

CHAPTER FIFTEEN

DEVELOPER'S BUDGET

15.1 Introduction

Prior to the purchase of a site for development, a developer must know what forms of development will be permitted on the site and have access to a financial appraisal or developer's budget (now often referred to as feasibility study). To decide whether the scheme is feasible, he will require advice on a fair price for the land; the probable building cost; and the probable rent or selling price of completed building(s).

Every development involving construction works has financial implication to those who initiate it, in addition to the benefits derived from its execution. Thus, in preparing a feasibility study of such a development the nature and objectives of the prospective client will have to be taken in to consideration in determining cost and revenue centres. Whether it is a public or private developer, there is the need to balance the cost factors with the revenue expectations throughout the life span of the development. However, while profit motive is usually the dominant indicator of the acceptance or rejection of private or commercially oriented projects, public investment is mostly embarked upon based on non-profit motives, such as social or political considerations.

15.2 Procedure for Preparing Developer's Budget

After getting a suitable land for development, the developer considers the type of development suitable for the site, he finds out from the local planning authority the planning permission available for the type of development. The basic size and design are considered by the architect while the rent likely to be realised is assessed by the Estate Valuer, other questions one may want to answer are:

(i) What price to be paid for the land?
(ii) The likely building cost.
(iii) The rent or selling price of the developed property.

To answer these questions, a developer's budget is prepared. The developer's budget is an attempt to assess the economic viability of a development and it contains the following items:

* Gross Development Value (GDV)
* The Cost of Erecting the Building.
* The Architect and Quantity Surveyors' (Consultants') Fees.
* Legal and Agents' Fees and Cost of Advertising.
* Developer's Profit.
* Cost of Finance (Interest on Borrowed Money).

15.2.1 Gross Development Value (GDV)

The type and outline of proposed building is decided upon. The total rent per area at which the property can reasonably be let is estimated properly by comparison with similar properties in the area. After estimating the total rent, a reasonable allowance for outgoings (maintenance, repairs and management) is deducted from this figure to obtain the net income per annum for the proposed premises. The net income is then capitalized by an appropriate year's purchase usually based on recent sales in the area. The capitalized figure is called Gross Development Value.

15.2.2 The cost of erecting the building

In practice the Quantity Surveyor does this. The cost will normally be computed per square metre of floor area and it will include site work. The developer will generally be concerned only with the usable floor area on which the rent is payable and allowance should be made for the circulation space usually between 5 – 35%.

15.2.3 Architect and quantity surveyors' (consultants') fees

The amount of fees for preparing drawings, bills of quantities, interim valuations and final account and for supervision is generally based on the cost of erecting the building; a reasonable figure is 10% of the erection cost of the building.

15.2.4 Legal and Agency Fees

An average allowance to cover legal cost on purchase of site including stamp duty, preparation and agreement of leases, agents' fees on lettings, the property and advertising cost would be 2 – 3% of GDV or 2 – 6% of building cost. The number of lettings would influence the sum involved.

15.2.5 Developer's Profit

An allowance of 10 – 20% of the GDV should be made to provide returns for the developer for his trouble and skills in carrying out the project and of the risk involved in the undertaken. The risk involved are; rising costs, falling rent, and inability to lease the property on completion. The actual allowance incorporated in a developers' budget will depend on the type of development and the degree of risk involved.

15.2.6 Cost of Finance

To purchase a building site, a developer will either have to borrow money on which interest will be payable or use his own capital and forego the returns on it, the interest paid or revenue forfeited should be charged to the development and will cover the period from date of purchase to the time when the completed building is let or sold. Financing the building operation will proceed throughout the contract period as payments are made to the contractor based on periodic certificates. The building cost of finance is usually calculated at an agreed rate of interest on half the building cost for the full contract period or the full building cost for half the contract period. The example below illustrates further:

Contract Period = 18 months
Building Cost = =N= 20,000,000.00
Building Cost of Finance = 18 x 20,000,000/2
= =N= 180,000,000.00

OR

18/2 x 20,000,000 = =N= 180,000,000.00

15.3 Steps for Computation of Developer's Budget

The following are the steps commonly used to compute developer's budget:

(i) The estimated developed value of the property is calculated based on existing building in the vicinity, and then deduct the outgoings and what is obtained is multiplied by the appropriate year's purchase (yp = 1/i) to get the developer's budget.

(ii) The known or estimated expenses like fees and developer's profit are deducted from the GDV.

(iii) The balance left is the estimated value of the land or sum available for the building depending on which was included in the expenses deducted from the GDV.

15.4 Worked Example on Developer's Budget Preparation

Example 15.1

Question: A developer wishes to purchase a site using the information below. Calculate the maximum amount the developer can offer for the site.

Information:

Building Area	=	24,000 m^2
Professional Fees	=	10%
Building Cost	=	=N= 600.00/m^2
Legal Fees	=	2 ½ %
External Works	=	=N= 850,000.00
Construction Period	=	15 months
Anticipated Gross Income	=	=N= 2,220,000.00 per annum
Outgoings	=	=N= 45,000.00 per annum
Financing Cost	=	5%
Developer's Returns	=	7% (to calculate year's purchase)
Developer's Profit	=	10%

Solution:

* To calculate GDV, we have;

Gross Income	=	=N=2,220,000.00
Ddt. Outgoing	=	=N= 45,000.00
		2,175,000.00
x Y.P = 1/i = 1/0.07	=	14.29
		=N=31,080,750.00

* To get the expenses, we have;

Cost of Building = 24,000 x 600	=	14,400,000.00
External Works	=	850,000.00
		15,250,000.00
Professional Fees (10%)		1,525,000.00
Balance c/f	=	=N=16,775,000.00
Balance b/f	=	=N=16,775,000.00
Financing: 1 ¼ yrs @ 5%		
= 16, 775,000/2 x 5/4 x 5/100	=	524,219.00
Legal Fees: 2 ½ % of =N=15,250,000	=	381,250.00
Developer's Profit: 10% of GDV	=	3,108,075.00
		=N= 20,788,544.00

* Cost of Land can now be computed as thus:

Gross development Value	=	=N= 31,080,750.00
<u>Less</u>: Expenses	=	=N= 20,788,544.00
		=N= 10,292,206.00

=N= 10,292,206.00 is the balance available for purchasing the site and financing purchase price. Therefore, if it is assumed that **=N= 515,000.00** is used for financing the purchase price, then the cost of the site is **=N=9,777,206.00**, i.e., paid for the land.

Example 15.2

Question: An estate developer approached your principal partner to discuss his intention to develop a hotel accommodation on one of his lands in Guzape District or Gwarimpa areas of the Federal Capital Territory, Abuja, Nigeria. Consequently, your principal partner had requested that you propose a comprehensive report on the critical factors to be considered for selecting the most suitable site for the project. Advise him.

Solution

Data:

- Gross floor area = 5,000m²

- Estimated annual rents = ₦2,000.00/m²
- Capitalization rate of rents (CP) = 7% (7 percent)
- Contract period = 12 months
- Professional fees = 15% (15 Percent)
- Short term Finance = 10% (10 percent)
- Developer's profit = 12% of GDV.
- Land costs (including fees) ₦10,000,000.00 **(11 marks)**

Computation:

Gross Development Value			**=N= : K**
Estimated annual rents:	=	=N=2,000 x 5,000m^2	= 10,000,000.00
Multiplied by (x) year's purchase:			
= 1/CP = 1/7% = 1/0.07	=	14.29 ----------------------	x 14.29

GDV	=		142,900,000.00

Building cost		**=N= : K**
GDV		142,900,000.00
Less:		
Land cost (including fees)		10,000,000.00

		132,900,000.00
Add:		
Professional fees (15% of 10,000,000)	=	1,500,000.00

		134,400,000.00
Short term finance: 10% for 1 year		
= 134,400,000.00/2 x 1year x 10%		
= 134,400,000/2 x 1 x 10/100 = 67,200,000 x 0.1		6,720,000.00
Developer's profit (12% of GDV):		
12% of 142,900,000.00 = 12/100 x 142,900,000.00	=	17,148,000.00

Building Cost	**=**	**N=158,268,000.00**

Example 15.3

Question: A site is available at a purchase price of =N=7,500,000.00 and it is anticipated that planning permission could be obtained for a factory of 7500m^2 or an office block of 17,500m^2. The estimated cost of the factory including site works is =N=18,000,000.00 and the comparable cost of the office block is =N=94,500,000.00. The contract periods are assessed at one year for the factory and two years for the office block. On completion, the office block is likely to have an annual rental value of =N=1,400,000.00 with the landlord's annual outgoings of =N=3,000,000.00. The normal return on office blocks in this area is 7%. The factory is likely to sell for =N=38,000,000.00 on completion. Legal, agency and advertising costs are likely to be =N=900,000.00 for the factory and =N=4,200,000.00 for the office block. Architect's and Surveyor's fees are 12% of construction costs and finance is at a specially advantageous interest rate of 9%. Determine the form of development likely to profit the developer most.

Solution

Factory Building Option:

Cost of Site	=	=N=7,500,000.00
Size	=	7500m^2
Estimated Cost (including site works)	=	=N=18,000,000.00
Contract Period	=	1 year
Selling Price	=	=N=38,000,000.00
Legal, agency and advertising costs	=	=N=900,000.00
Architect's and Surveyor's fees	=	12% of construction costs
Cost of finance	=	9%

<u>Computation</u>:

Gross Income: **=N= : K**

Selling Price = 38,000,000.00

<u>Less Expenses</u>:

i. Cost of Site = 7,500,000.00

Sub-Total = 30,500,000.00

ii. Building cost = =N=18,000,000

Add Professional fees:

12% of =N=18,000,000 = =N= 2,160,000

=N= 20,160,000

Add financing cost:

= 20,160,000/2 x 1yr x 9%

=10,080,000 x 0.09 = =N= 907,200

Add Legal etc. fees = =N= 900,000

=N= 21,967,200 ----------------- <u>21,967,200.00</u>

Net Profit on Investment (Factory Building) = =N=<u> 8,532,800.00</u>

Office Block Option:

Cost of Site	=	=N=7,500,000.00
Size	=	17,500m^2
Estimated cost (including site works)	=	=N=94,500,000.0
Contract Period	=	2 years
Average Annual Rent	=	=N=1,400,000.00
Landlord's Annual Outgoings	=	=N=3,000,000.00
Return on office blocks	=	7%
Legal, agency and advertising costs	=	=N=4,200,000.00
Architect's and Surveyor's fees	=	12% of construction costs
Cost of finance	=	9%

<u>Computation</u>:

Gross Income:		**=N= : K**
Average Annual Rent	=	1,400,000.00
Multiplied by Y.P (1/i) = 1/7% = 1/0.07	=	x 14.29
		20,006,000.00
Less Outgoings	=	3,000,000.00
Gross Income		**17,006,000.00**
<u>Less Expenses</u>:		
i. Cost of Site	=	7,500,000.00
Sub – Total	=	9,506,000.00

ii. Building cost = =N=94,500,000
Add Professional Fees
12% of 94,500,000= =N=11,340,000

=N=105,840,000
Add financing cost:
= 105,840,000/2 x 2yrs x 9%
= 52,920,000x2x 0.09 = =N= 9,525,600
Add Legal etc. fees = =N= 4,200,000

=N=119,565,600 ------------- <u>119,8565,600.00</u>
Net Profit on Investment (Office Block) - (=N<u>= 110,059,600.00</u>)

DECISION

Based on the mathematical evaluation carried out, the factory building option with a positive balance is more profitable than the office block option with a negative balance.

CHAPTER SIXTEEN

MORTGAGE FINANCING

16.1 Introduction

Long term development finance is normally raised either by mortgage or, particularly in times of credit shortage, by sale and leaseback. Following the Second World War, long term mortgages on commercial and industrial property were provided by insurance companies and were mainly fixed interest. In the 1990s, both fixed and variable interest mortgages were available for periods up to 25 years and on a variety of terms to suit the needs of individual projects and borrowers and can encompass the development period as well as the long term.

16.2 The Concept of Mortgage Financing

There are three basic methods of repayment:

(1) **Equal Instalment Method:** This is a method whereby equal amounts of capital are repaid periodically over the loan period, accompanied by declining outstanding capital and interest payments.

(2) **Annuity Payments:** This is normally adopted for building society mortgages, whereby assuming no change in the level of interest rates, the combined interest and capital paid each period remains constant over the term of the loan; initially payments consist largely of interest but later of an increasing proportion of capital.

(3) **Interest Only:** In this method capital is repaid in a lump sum at maturity and this is usually confined to relatively short-term loans.

Alternatively, repayment tranches may be spaced over the loan period; for example, a 21-year loan might have one third repayable after each of seven years, 14 years and at maturity.

The amount lent on a mortgage has normally been restricted by two criteria:

(1) The sum lent should not exceed two thirds or occasionally three quarters of the value of the property mortgaged;

(2) The net rental income from the property must exceed interest and any periodic capital repayments.

The example below shows how these two criteria can be met and sufficient mortgage capital raised for long term funding.

Worked Example
Question:
A prime commercial development was completed at a total cost of =N=4.9 million. The market value of the property was =N=7 million and it was fully let for a net rental income of =N=490,000.00 per annum. Mortgage finance amounting to 70 percent of the market value was repayable on an annuity basis over 25 years at a fixed rate of interest of 6.5 per cent (mortgage instalment = =N= 401,730.00 p.a). Calculate the capital surplus/deficit and the net income surplus.

Solution:

	=N=
Development Cost (including short term finance)	=N= 4,900,000.00
Mortgage Debt (70 per cent of =N=7million)	=N= 4,900,000.00
Capital Surplus/Deficit	NIL
Net Income Rent	=N= 490,000.00 p.a
Mortgage Instalment	=N= 401,730.00 p.a
Net Income Surplus	=N= 88,270.00 p.a

This confirms the self-financing aspect in that:

(1) The long-term mortgage was sufficient to repay all short-term finance raised to pay development costs, and

(2) Net rental income was more than sufficient to pay annual mortgage interest and capital repayment.

An alternative to the straight mortgage is the mortgage debenture, whereby funds are advanced against the security of a particular property, but in addition the lender has a charge over all assets of the company, repayment of the mortgage debenture is at the end of the loan period and the lender has a fixed interest investment with a substantial security but no hedge against inflation. Another variation, on the other hand, is the convertible loan stock, whereby the lender has an option to purchase ordinary shares in the company at some future date at a fixed price in proportion to the amount of loan stock held. If the lender does not take up his option, he continues to receive interest at an agreed rate until the redemption date. The lender thereby links the advantages of a fixed interest stock with protection against inflation.

CHAPTER SEVENTEEN

CASH FLOW FORECASTING

17.1 Introduction

The assessment of the profitability of a particular contract consists basically of knowing precisely the value of work executed at a specific date, compared with the actual costs incurred in achieving that value of work. The difference between the two figures will be the amount available to allocate to the off-site overheads of the company, to fund its working capital and make a profit. In an adverse situation the difference may show that off-site overheads are not being covered and that no profit is being made. In the worst situation, the actual costs of construction on site may exceed the value of the work that those costs have generated.

The usual reason given for a company's difficulties is cash flow, whereas this is more often a symptom of the problem and not the cause. Many construction companies become insolvent through bad estimating and planning, ineffective contract control or inadequate site cost control.

17.2 Concept of Cash Flow in the Construction Industry

Cash flow can be defined as the actual movement of money in and out of a business. Within a construction organisation positive cash flow is derived mainly from monies received through monthly payment certificates. Negative cash flow is related to monies expended on a contract to pay wages, purchase materials and plant and meet subcontractors' accounts and overheads expended during the progress of construction.

On a construction project, the net cash flow will require funding by the contractor when there is a cash deficit; where cash is in surplus the contract is self-financing. With contracts operating under United Kingdom standard conditions with retention funds and low percentage profits on turnovers, construction firms are frequently in financial deficit for much of the contract period.

Cash flow problems can be reduced if effective procedures can be operated by the contractor in respect of the following matters:

(1) Realistic monthly assessment of preliminaries from fully documented and priced preliminary schedules;
(2) Increased costs under contracts with fluctuations kept up-to-date in monthly valuations;
(3) Variations to the contract accurately assessed and included in valuations;
(4) Daywork sheets completed and cleared for monthly payment;
(5) Discounts and retention monies properly claimed against the contractor's own nominated subcontractors and suppliers;
(6) Collection of all monies properly due to the contractor; and
(7) Ensuring that all claims for loss and expense are; fully documented, properly presented and submitted as quickly as possible.

17.3 Budget and Cash Flow

A budget, usually annual, is the association's plan of work converted into financial terms. The budget estimates how much it will cost to achieve the targets and how much income the work will generate. It must achieve specific criteria and have regard to the constraints imposed by either Rent Surplus of Revenue Deficit Grant Requirements. Within the budget there are three separate areas which should be balance:

(1) Capital Expenditure on property development should not exceed approved advances from the lending authority and, as appropriate, the charitable or private funds or loans available;
(2) All development administrative costs should be within the Housing Association Grant (HAG) administrative allowances; even where no HAG is to be paid, the allowances provide a useful guide;
(3) The cost of managing and maintaining properties should be within the administrative allowances for management and maintenance respectively, and avoid and bad debts should be within the allowances for these rent losses.

Whereas the budget will show the management committee whether over a period the association can afford to undertake the desired programme of work, the cash flow forecast indicates whether at any given time it will have the cash in hand to pay for the work. Statutory grants available to housing associations are sometimes delayed so that working capital will be necessary. This is often obtained in the form of a loan from a bank or financial institution, sometimes with a guarantee from the Housing Corporation. The management committee must satisfy itself that the association is making the best use of its cash resources and minimising interest charges.

CHAPTER EIGHTEEN

TAXATION

18.1 Introduction

Taxation is a compulsory levy by the government through its agent on the profits, income, or consumption of its subjects or citizens. It is also viewed as a compulsory contribution made by individuals and organization towards defraying the expenditure of government. It is a charge levied by the government on the income or wealth of a person or corporate organization for the common benefit of all. The term does not include specific charges made against a particular person or properties for current or permanent benefits and privileges accruing only to those paving such charges. Taxation can also be defined as the transfer of real economic resources mum private sector to the public sector to finance public sector activities. It can therefore be concluded that the essence of all taxes is the removal of resources from private hands of' the individual, families, corporate bodies, communities and trusts to the public sector to finance the development of the society. The need for government in the affairs of man is therefore the basis for taxation in societies. As such, below are the purposes of taxation:

a) As a revenue source to defray government capital and revenue expenditure.
b) It is fiscal policy instrument employed by government to regulate the economy.
c) Tax can also be used to encourage investment in the priority sectors of the economy.
d) It is also a means of controlling consumption of some harmful goods and services e.g., cigarette, alcohol, cinema, etc.
e) The equity principle in taxation facilitates the application of 'rule of 1aw.'
f) It is resource redistribution mechanism in the economy to reduce the gap between rich and poor. In other word, income redistribution.
g) The taxpayer identification programme introduced by Federal Inland Revenue Service serves as database on biography of both individual and corporate taxpayers.
h) The versatility of tax operation creates job opportunity for tax practitioners and tax collectors.
i) Recent developments show taxation as an agent for increased patriotism.

18.2 Types of Taxation

Broadly taxation can be classified into direct and indirect taxation. This was in an analysis of the 'impact and incidence' it has on the tax payer. In direct taxation, the tax payer receives the consequence of taxation almost immediately. This clearly is the case in Pay as You Earn (PAYE). Others are Personal Income Taxes (PIT), Companies Income Taxes (CIT), withholding tax, Petroleum Profit Tax (PIT) and Capital Gains Tax. On the other hand, in indirect taxation the consequences on the taxpayer differed to a later period (period of acquisition or consumption). Examples of this include value added tax (VAT), import duty, excise duty etc. Other classification is in relation to income and property taxation with income mainly based on profit or other incomes e.g., companies' income tax, personal income tax, petroleum profit tax, and value added tax where property taxes relate to taxes on capital like capital gains tax, and import duty. All these classifications are wide in nature but the essence to drag every economic activity into the tax net.

18.3 Evolution of Income Tax in Nigeria

Taxation is a key to the character and functioning of the state, economy and Society, and its effectiveness and the levels of compliances greatly depend on acceptance by citizens of its legitimacy. Fiscal sociologists suggest that the shift front earlier forms of tax state to a modern fiscal state based on public finance is both facilitated by and enables the separation of an apparently private sphere of economic activity from the public sphere of the state.

The income tax began as a tax on the small section of society which was well off on individual income and on the income or profits of legal persons such as companies from business or commercial activities. It enabled state finance to move away from reliance on a multiplicity of duties and charges, which fell disproportionately on the poor. Its legitimacy was based on the principle of proportionality, justified by the concept of ability to pay, which was reinforced by the shill to a progressive and graduated tax system (higher tax rates on higher income). Its acceptance and eventual spread to become a mass tax was linked to wartime patriotism, as well as the need to finance a. growth in welfare spending, with the first introductions of social security programmes early in the 20th century and their major expansion in its second half, Since the 1970s tax revenue as proportion of Gross Domestic Product

(GDP) has continued to rise in Organization For Economic Cooperation And Development (OECD), from around 23% in 1965 to a weighted average of 33% in 1999 and despite the impact of privatization and the derive to ‘roll back the state’, state expenditures have remained in the 3 5-50% range.

18.4 Effect of Taxation

In Western societies, at least, private purchasers and business firms are tax payers. The effect of tax is often to reduce the effective cost of a building to the building user but the tax regulations differ from country to country. This situation arises because interest is treated as revenue or income tax purposes. Therefore, taxable income is reduced if interest is foregone or paid. The following points are also worth noting:

a) The effect of tax is often much less for house purchasers.

b) Business building users and, up to a point, owner-occupiers who are not borrowers receive a substantial tax benefit which may reduce the cost of a building by as much as one half.

c) The Government obtains tax revenue from buildings rented for private occupation. This they do not obtain from other types of occupation.

d) The incidence of taxation varies from one country to another according to the tax laws in the country.

CHAPTER NINETEEN

ECONOMICS OF PREFABRICATION AND INDUSTRIALIZATION OF DEVELOPMENTS

19.1 Introduction

Industrialization of the construction method implies the reorganization of resources in such a fashion as to create an industry that manufactures or constructs buildings of related components in a manner that is superior to the traditional method previously employed. The basic concept of industrialization is the reorganization of the whole construction process in an integrated way so that materials, components, plants and labour are available at the appropriate times to secure continuity both in the factory and on the site. Industrialization of construction method must satisfy both economic and technical factors before it can be considered a viable and suitable venture. Economics of prefabrication and industrialization of developments lies on the objectives, advantages, disadvantages and the general prerequisites of industrialized construction. The dream of a mass housing project within the shortest possible time to ease housing problem in a community can be brought to reality by prefabrication and industrialization of development projects.

19.2 Prerequisites for Industrialized Construction

The following are the major prerequisites for the adoption of industrialized system of construction:

a) Continuous production of standardized components. The primary objective of industrialization is to reduce unit costs through continuous production of standardized components.
b) Steady supply of vital resources essential to construction among which are:
    - Land supply
    - Money supply
    - Labour and material supply
    - Supply of information
    - Easy access to transportation
c) Continuity in demand.
d) Maximum efficiency and economy are being achieved by mass production methods in factories.

19.3 Advantages of Industrialized Construction

The following are the major advantages of the industrialized system of construction:

1. Reduction in actual construction time and as a result, savings in the cost of capital (interest paid) and minimising effect of inflation {efficient traditional construction requires about 2000hrs to build a flat in a high storey building, efficient concrete panel system of industrialized building would require 1100 man-hrs. Precast construction slabs in construction reduce time of construction by 20%. The record – 28m (7 storeys) office block erected in Hamburg (Germany) in less than three days. In Europe man houses need about 18-25 man-hours per metre squared; manufactured houses about 5-7 man-hours per metre squared}.
2. Elimination of formwork and scaffolding and associated with the latter.
3. Higher quality of product and better working environment.
4. Increased productivity, partly due to repetition.
5. Reduction in waste of materials.
6. Reduction in loss of time due to weather in elements.
7. Purchase of materials in bulk for prefabrication in the factory.
8. Reduction in accidents on sites.
9. Site preparation is limited to services, foundation, external works and may even be absent in some methods of industrialized construction such as mobile housing and house boats.

19.4 Disadvantages of Industrialized Construction (in Terms of Cost)

The following are the major disadvantages of the industrialized system of construction:

1. Transportation and erection costs increase. Up to 30% of the cost of components is due to their transportation from factory to site.
2. Industrialized methods create a demand for new skills and must be backed with increase in wages.
3. The need for concentration of capital-intensive plants and equipment and of highly qualified personnel to work and service them (in addition, the plants and equipment used for industrialized building method are expensive to operate).

4. The need for thorough and skilled programming to synchronize all operations for effective utilization of plants and equipment.
5. High capital investment with high interest charges. Cost of designing and testing of systems and production process including prototype where required. The investment per operative in building might be 3 times as much as that for conventional building.
6. Jointing of components may be expensive.
7. Industrialized buildings are more expensive in maintenance.
8. More expensive demolition because of the difficulties at the joints between components.

19.5 Basic Terms in Industrialized Construction Techniques

The following are some of the basic terms most often used in industrialized construction techniques:

19.5.1 Standardization

This is a process of formulation and applying rules for orderly approach to specific activity for the promotion of optimum overall economy. Optimum standardization is for component manufacturers to obtain larger series runs to balance turn-over against capital, reduce production costs by the bulk purchase of materials. Standardization promotes savings in labour and materials, smaller stocks, longer production runs and lower production costs. However, standardization is a costly and time-consuming process. It is particularly expensive in the research and development effort.

19.5.2 Mechanization

This is a major factor in the industrialization of construction and a prerequisite for increased productivity. Mechanization means the performance of all basic and auxiliary heavy and labour-consuming operations by machines and mechanized devices. It ensures a specified rate of construction work that leads to better performance in term of productivity, labour input and construction work cost.

19.5.3 Automation

This refers to replacement of manual labour with automatic program-controlled devices. Introduction of automated systems for managing construction and construction industry plant as well as introduction of automatically controlled working tools. Automation improves the quality of work, ensures required productivity and is directed towards economic and rational use of resources (for example, the use of automated graders due to greater accuracy of soil grading reduces consumption of crushed stone up to 200 cubic metres per km of road). Radio remote control tower cranes accelerate the erection of high-rise building by 30%. Automated concrete mix preparation without large capital investment.

19.5.4 Modular Co-ordination:

Presently, there is no common module of dimensions for different components like bricks, floor tiles, joinery, glass panes and various other fixtures. This results in considerable wastage of materials and labour.

PART IV

BASICS OF COST MANAGEMENT AND CONTROL

CONTENTS

CHAPTER TWENTY

PRINCIPLES OF COST CONTROL

20.1 Definition of Cost Control

Cost control can be defined as all methods of controlling the cost of building projects within the limits of a pre-determined sum or cost plan throughout the design and construction stages. It involves the control of both design and production costs so that inputs and outputs fall within determined limit. This implies that:

1. A system exists for predicting cost. There must be a frame of reference or set of conditions to be adhered to that is a realistic estimate.
2. A method also exists to ensure that a predicted value is achieved that is a plan of how the estimates should be spread among the parts of the building. This means that a cost target must be given to each element or part of the building. The summation of all the cost targets represents the cost limit for the project.
3. A method exists for measuring the output of various inputs. There must be a method of checking or feedback which means that the estimate is being spent as originally budgeted. This exercise by which we measure feedback is known as cost checking.
4. A control mechanism is built into the system where variances are adjusted to suit predictions. There must be a means of remedial action that is taking necessary action if any one of the elements is getting higher in cost than the amount budgeted for it. If suitable remedial action is not possible, the client may have to provide additional funds, signifying a failure of cost control. The client should be convinced of the necessity for additional funds.
5. A system exists for transmitting information so as to update input on project data. While operations are in progress, the planning data are checked and results fed back to the estimator for future use.

20.2 Concept of Cost Control

Cost control in its widest application aims at ensuring that resources are used to best advantage. A client is concerned that his/her building is soundly constructed at a reasonable cost and within a prescribed period of time. The basic criteria for determining the success of a project are: cost, time and quality.

1. **Cost:** This covers economic construction and layout, low future maintenance and operating costs.
2. **Time:** This means that a project should be completed on schedule as time lost is lost money.
3. **Quality:** A building which is soundly constructed to a satisfactory standard of quality and appearance and well suited to perform the functions for which it is required.

Building cost certainly forms an important aspect of design. It is considered as the medium that brings together purpose and design. Clients of construction projects are forced to demand that professional advisers accept cost as an element in design because of rising prices, restrictions on the use of capital and changing interest rates. To do this, the advisers have to accurately forecast overall cost and ensure that cost is suitably balanced throughout all parts of the building construction.

20.3 Importance of Cost Control

The need for cost control for construction projects has considerably in recent times for a number of reasons which include:

1. There is greater urgency to complete projects in good time to reduce the amount of unproductive capital or borrowed money. Also, few clients have no time for re-designing of schemes when high tenders are received.
2. Client's needs are becoming more complex. Individual developments are becoming larger and complicated with more consultants being employed on site.
3. Client's organisation, both public and private, are using more sophisticated forecasting and budgeting techniques and they therefore expect a high level of efficiency and expertise from their professional advisers. They also require a broad and comprehensive range of services.
4. New construction techniques, materials and components create greater problems in assessing the capital and maintenance cost of building.
5. The move towards reduced wastes and better use of resources creates a need for improved cost forecasting and management.
6. Increasing demand for integrated design for an efficient combination of building and services elements particularly in complex developments such as hospitals, housing estates, high rise buildings, etc.

7. More attention needs to be paid to life cycle costing and total cost appraisal.
8. Changing prices and variable interest rates.

20.4 Roles of a Quantity Surveyor in Project Cost Control

Ikupolati and Olaleye (2016) highlighted the roles of a quantity surveyor in project cost control as follows:

1. Interchange between capital and running cost to obtain the minimum total cost.
2. Investigating alternative ways of producing the same structure at lower cost.
3. Finding a way of slightly altering the building so that greater use of resources is achieved and, the returns are more than proportionately increased.
4. Investigating methods of using the same resources to produce a different building which could give greater returns.

The Quantity Surveyor should also bear in mind that the cost is not the only design criteria. It is possible to reduce cost at the expense of quality, size, function or even aesthetics. This may not work out for the best at all times. A proper balance should be maintained. An economically priced project is required, but not necessarily the cheapest as certain standard of quality has to be maintained. In summary, the Quantity Surveyor serves as a construction economist in construction project cost control. The main objectives for engaging the Quantity Surveyor in project cost control can be divided into six project stages as shown in Table 20.1:

Table 20.1: Objectives of Quantity Surveyor's Services in Project Cost Control

S/No	Stage	Activities
1	Inception	Appraisal; Establishing the needs and wants of the project; Strategic briefing; Financial and economic considerations; Whole-life considerations
2	Design	Sketch design; detailed design; Tender preparation
3	Construction	Construction methods; Project planning; Time, cost and quality
4	In-use	Commissioning; Repair, replacement, refurbishment, demolition
5	Facilities Management	The project and its use
6	Sustainability	Environmental consideration

Source: Ikupolati and Olaleye (2016)

20.5 The Process of Cost Control

The process of cost control can be broadly categorized into two stages:

1. Pre-contract cost control or cost control at design stage
2. Post-contract cost control or cost control at construction stage

20.5.1 Cost control at design stage (Pre-contract)

There are three (3) basic operations involved at this stage. These are:

1. Preparation of preliminary approximate estimates of the cost of the whole of the project.
2. Preparation of a cost plan which apportions the estimated expenditure among the various elements of the building.
3. The exercise of cost control by the regular checking of the plan as the design is developed, to ensure the variances with the proposed expenditure are listed in the modification made to the design if necessary.

The process involves a close interaction between the cost manager (usually the Quantity Surveyor) and the designers (that is the Architect and Engineers).

20.5.1.1 Preliminary approximate estimate

The preliminary approximate estimate has to be a realistic estimate that takes into consideration all the factors concerning the project. It may be based on the client's brief or on initial outline proposals of the designers. This estimate once approved by the client sticks in the client's mind and every effort must be made by the cost manager, the designers and the supervisors of the project to ensure that the final account figure remains as close as possible to this initial estimate. In other words, this figure becomes the cost limit for the entire project.

20.5.1.2 Cost plan

A cost plan may be defined as a statement of the proposed expenditure on each section or element of the new project as related to a definite standard of quality. Each item of cost is generally regarded as a "cost target" and is usually expressed in terms of cost per square metre of gross floor area for buildings or as a total cost of the element. In cost plan, a cost target must be given for each element and a summation of these cost targets represents the cost limit of the entire project.

20.5.1.3 Cost checking

Cost checking is the process of checking the estimated cost of each section or element of the project as the detailed designs are developed against the cost target set against it in the cost plan. Remedial action is taken if one of the elements is getting higher than budgeted, either by re-designing some other less critical elements to reduce its cost.

20.5.2 Post contract cost control (Construction stage)

At the construction stage, it is fair to assume that the Quantity Surveyor has been successful in the reconciliation of the cost plan/cost limit and the tender sum, so that an acceptable and manageable contract figure has been produced. If this is so, then it can be said that the cost planning of a project is complete at the design stage. As soon as the contract is signed, a realistic post contract cost control system must be put in place. It is at this stage that the designs are translated into reality and payments, contractual disputes, etc. are settled according to the contract documents which comprise articles of agreement, contract conditions, preliminaries, trade preambles and bill of quantities. This stage calls for proper and efficient management, lack of which can lead to cost escalation of the project. The Quantity Surveyor's responsibilities are both traditional and self-imposed. The traditional responsibilities of the Quantity Surveyor are limited to the following:

1. Preparation of bills of re-measurement for variations and provisional sums.
2. Preparation of valuation for Architect's certificates.
3. Supervision of work as it progresses.

Once contract has been signed between the client and the selected contractor, the agreed contract sum can only be altered where the conditions of contract expressly allow for such alteration. Most contract forms allow the contract sum to be altered if the following events occur:

1. Variations
2. Fluctuations
3. Re-measurement of provisional quantities
4. Adjustment of provisional sums
5. Adjustment of prime cost sums
6. Claims for loss and expense

20.5.2.1 Variations

Variations are basically alteration in the design, quantity or specification and construction methods from what was initially agreed in the contract documents.

These could take many forms, but many variations are as a result of poorly detailed designs and working drawings. Many variations also occur as a result of the client changing his mind during construction about some aspects of the building. Client should be informed of the cost implications of any variations.

20.5.2.2 Fluctuations

Fluctuations are increases or decreases in the prices of the basic inputs into construction, that is, materials, labour and plant. These fluctuations are usually outside the control of both the client and the contractor, but systems of advanced payment for materials if properly managed can help in controlling cost during construction.

20.5.2.3 Adjustment of provisional sums

Provisional sums are included in the contract sum for work which cannot be measured, probably because there is no design at all for the component. Again, if time is spent in producing detailed design, provisional sums will become necessary.

20.5.2.4 Re-measurement of provisional quantities

Provisional quantities are an improvement in that there are some attempts to measure the component of a building. The quantities are marked provisional because it may not be possible to define the extent of the work involved until one gets to site. This is usually the case with work underground.

20.5.2.5 Adjustment of prime cost sums

Prime cost sums cover work to be carried out by nominated subcontractors and goods to be supplied by nominated suppliers. By obtaining quotations from these nominated subcontractors and suppliers before going to tender, helps in getting realistic figures for prime cost sums and adjustments of these will not drastically alter the contract sum.

20.5.2.6 Claims for loss and expense

Claims for loss and expense come in a variety of forms. The most common are usually claims for additional cost of disruption of work when the client has defaulted in some way in his/her part of contract. The most common default with government agencies has been found to be delay in payments. Contract forms in Nigeria today allow the contractor to do either one or all of the following for delayed payments:

1. Claim for extension of time and the additional cost of disruption of work.
2. Claim for interest on overdue payment.
3. Terminate the contract.

In order to avoid these additional costs, clients should honour their part of the contract and also reduce to a minimum the number of variations requested.

Cost control at construction stage involves close monitoring of the work as it is going on. The Quantity Surveyor should keep the client informed of the financial position of the contract at agreed regular intervals, often monthly. The client should have an idea not only of the current cost position, but also the likely pattern of future expenditure over the rest of the contract period in order that he/she may have sufficient funds available to honour certificates of payment as they are issued. Valuations and variations should be reviewed regularly to ensure that over payments and under payments are not made and that variations approved can be contained by the contingency sum for the contract.

20.6 Project Cost Control

Project cost control is like two sides of a coin that affect each other. The objective of planning is to arrive at baselines, which will be used for control. Control involves monitoring performance, comparing it to the baselines produced by planning, taking corrective action where necessary and collecting and analysing performance data which are used to revise and produce new planning baselines either in the present of for the future. The relationship between planning and control as it affects cost if shown in Figure 20.1.

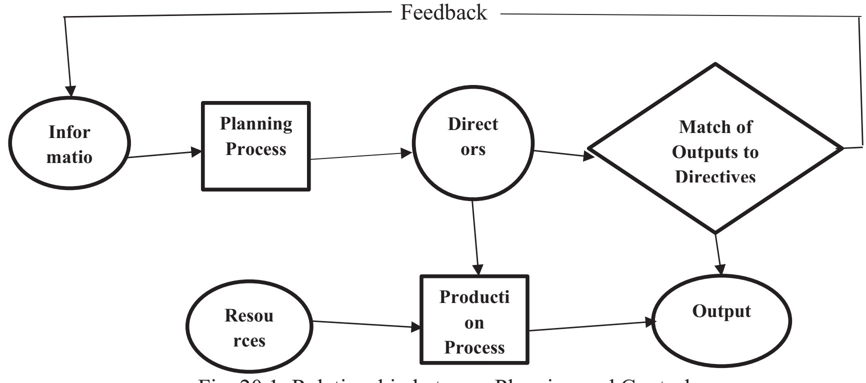


Fig. 20.1: Relationship between Planning and Control

In view of the relationship between planning and control, illustrated in Figure 19.1 in the previous section, the roles of a quantity surveyor at the various stages of construction projects are summarised in Table 19.2.

20.7 Roles of a Quantity Surveyor at the Various Stages of Construction Projects

In view of the relationship between planning and control, illustrated in Figure 20.1 in the previous section, the roles of a Quantity Surveyor at the twelve (12) stages of construction projects are summarised in Table 20.2.

Table 20.2: Roles of a Quantity Surveyor at the Various Stages of Construction Projects

Item	**Stage**	**Purpose of Work and Decision Required**	**Task Required**	**People Involved Directly**	**Usual Terminology**
A	Inception	To prepare the general outline of requirement and plan future action	Set up clients' organisations for briefing, consider requirements, appoint Architect	All clients' interests, Architect	Briefing
B	Feasibility	To provide the client with an appraisal and recommendation in order that he may determine the form in which the project is to proceed, ensuring that it is feasible, functionally, technically and financially.	Carry out studies of user requirements, site conditions, planning design and cost, etc. as necessary to reach decision.	Client's representatives, Architects, Engineers, and Quantity Surveyors according to nature of the project.	
C	Outline Proposals	To determine the general approach to layout design and construction in order to obtain authoritative approval of the client on the outline proposals and accompanying report.	Develop the brief further, carry out studies on user requirements, technical problems, design and costs, as necessary to reach decisions.	All clients' interest, Architects, Engineers, Quantity Surveyors and specialists as may be required.	Sketch Plans
D	Scheme Design	To complete the brief and decide on the particular proposals, including planning arrangement, appearance, constructional method, outline specification and cost, and obtain all approvals.	Final development of the brief, full design of the project by Architect, preliminary design by Engineers, preparation of cost plan and full explanatory notes by the Quantity Surveyor. Submission of proposals for all approvals.	All clients' interest, Architects, Engineers, Quantity Surveyors and specialists and all statutory and other approving authorities.	

THE BRIEF SHOULD NOT BE MODIFIED AFTER THIS POINT					
E	Detailed Design	To obtain final decision on every matter related to design, specification, construction and cost.	Full design of every part and component of the building by collaboration of all concerned, complete cost checking of designs.	Architects, Quantity Surveyors, Engineers and specialist contractor (if appointed).	Working Drawings
ANY FURTHER CHANGE IN LOCATION, SIZE, SHAPE OR COST AFTER THIS PERIOD WILL RESULT IN ABORTIVE WORK					
F	Production Information	To prepare production information and make final detailed decisions to carry out work.	To prepare production information i.e., drawings, schedules, and specifications.	Architects, Quantity Surveyors, Engineers and specialist contractor (if appointed).	
G	Bills of Quantities	To prepare and complete all information and arrangement for obtaining tender.	Preparation of bill of Quantities and tender documents.	Architects, Quantity Surveyors, contractor (if appointed).	
H	Tender Action	Actions as recommended.	Action in accordance with purpose of work and decision to be taken.	Architects, Quantity Surveyors, contractor, client.	
I	Project Planning	Action in accordance with task to be done in concluding, including project management.	Action in accordance with task to be done including project management.	Contractor, sub-contractor.	Site Operations
J	Site Operations	Action in accordance with task to be done in concluding, including project management.	Action in accordance with paragraphs 11-14 including project management.	Architects, Engineers, Contractors, Subcontractors, Quantity Surveyors, Client.	
K	Completion	Action in accordance with task to be done in concluding, including project management.	Action in accordance with paragraphs 15-18 including project management.	Architects, Engineers, Contractors, Subcontractors, Quantity Surveyors, Client.	Site Operations
L	Feedback	To analyse the management, construction and performance of the project.	Analysis of job records, inspection of completed buildings. Studies of building in-use.	Architects, Engineers, Contractors, Subcontractors, Quantity Surveyors, Client.	

Source: Seeley (1996)

The roles of a Quantity Surveyor in each of the twelve (12) stages of construction projects, summarised in Table 20.2, are hereby discussed.

20.7.1 Inception stage

This is the period which the client decides to embark on a building project. During this period, the idea of the client is usually not clear and needs to be crystallized. The client at this period sets up an organisation for briefing, that is the general outline and plan for future action. The brief usually includes report on existing building of the same or similar type. The appointment of a Quantity Surveyor and Architect should be done at this stage, for proper project evaluation or appraisal. At this stage, the Quantity Surveyor can only give or quote from previously executed similar projects that are available and accessible from his/her cost planner or record. The estimate of the project cost given by the Quantity Surveyor at this stage or point is very uncertain but gives a range of probable cost for the proposed project.

20.7.2 Feasibility stage

This is the stage where the client requires a recommendation as to whether the project is viable in terms of functionality, finance and technicality. At this stage, the Architect must ascertain broad requirements from the client's brief. The Architect and Quantity Surveyor should study these factors at the proposed site and make recommendations. If the project is not viable at this stage, it should be made known to the client and where the project is viable, the Quantity Surveyor prepares the cost limit by preliminary approximate estimate. When provisional estimate of the project was arrived at by a method of comparative estimate or in circulation basis, an allowance should be considered for factors like locations, site conditions, market conditions and quality of work.

20.7.3 Outline proposals stage

At this stage, the client requirement has been confirmed to be viable and the site is surveyed. The Architect begins to consider the various alternatives in which the building can be designed and constructed. Some drawings will be produced at this stage and the Quantity Surveyor will be in position to give guidance on cost and in particular to evaluate the financial effect and give the possible solution to any particular problem and prepare an outline cost plan.

20.7.4 Scheme design stage

The major planning problem is resolved at this stage and the outline design of the building project is completely produced. Sketch design includes sections and elevations, services and finishes drawings, etc. At this stage, the Quantity Surveyor checks his/her approximate estimate figure and with the aid of extensive cost information, re-appraises or evaluates the initial cost plan with provisional target and cost figure for each element or major parts of the building. The brief of the client should not be modified any longer because further modification of the brief can frustrate the previous work done. At the end of the sketch design stage, the client should have the following:

1. Visual realisation of the building.
2. Specialist proposal.
3. Outline specifications.
4. Elemental breakdown of costs.

20.7.5 Detailed design stage

Decision on every issue relating to design specifications and construction are completed. The Quantity Surveyor is called upon to give a comparative cost of materials and services layout and adjust the distribution of costs in the cost plan if required. He/she also gathers more information on cost relevant to the project and cost checks. It is important to know that any further change in size, shape or cost after this time will result in abortive cost.

20.7.6 Production information stage

The Quantity Surveyor obtains all relevant information from team members, sub-contractors and suppliers to prepare a realistic estimate. He/she continues to cost check on the data produces against the final cost plan and advise the design team on any financial or contractual matters associated with the project including the terms and conditions of the main contract and sub contracts and on the selection of tenderers.

20.7.7 Bill of quantities stage

The Quantity Surveyor has sufficient information to produce an accurate bill of quantities. It is expected that the level of accuracy should be within plus or minus 5% of the actual cost of the project. A complete set of bills of quantities should contain sufficient information concerning the structure produced. This can be achieved by collaborating with all other interest groups concerned. A complete cost checking based on the final designs by the Quantity Surveyor is achieved. It is important for the client to be properly informed of these final decisions and approval obtained to avoid possibility of future alteration to the scheme.

The major task of the Quantity Surveyor at this stage is to compare the cost of different forms of construction methods, cost of different materials, components and services including service layout and adjust the cost distribution in the cost plan if required. It is expected at this level that the comparative cost study will be put into consideration. The probable running and maintenance costs of materials and components where they are perceived to likely cause significant effect on the outcome of proposal, are taken care of.

20.7.8 Tender action stage

Decisions have been reached on the tendering procedure to employ. The role of a Quantity Surveyor at this stage is preparation of the tender analysis which is a breakdown of each tendering contractor's details, tender sum and the time he/she will use to execute the project. He/she also prepares the report on the tender and recommends a suitable contractor.

20.7.9 Project planning stage

After the initiation of stage, the project is planned to an appropriate level of detail. The main purpose is to plan time, cost and resources adequately to estimate the work needed and to effectively manage risk during project execution. As with the initiation process group, a failure to adequately plan greatly reduces the chances of the project of successfully accomplishing its goals. Project planning generally consists of the following:

1. Identifying deliverables and creating the work breakdown structure,
2. Identifying the activities needed to complete those deliverables and networking the activities in their logical sequence.
3. Estimating the resource requirements for the activities.
4. Estimating time and cost for activities.
5. Developing the schedule.
6. Developing the budget.
7. Gaining formal approval to begin work.

20.7.10 Site operation stage

This stage is where construction takes place. It deals with the management and operations of what takes place on the site which is referred to as a "system". The related components of construction site operations operate as sub-systems. These sub-systems include site information, surveying and preparation, establishment, amenities, protection, safety, management and construction sequence. Intended outcomes include: understanding of site selection and management principles and procedures. Understanding of the nature and function of the various parties that are involved in a construction site. These would include owner, main contractor, builder, subcontractors, building inspectors, surveyors and suppliers and understanding of the external factors that can impact on site selection, and efficient operation of a construction site.

20.7.11 Completion stage

On completion of the project, a few steps must be followed to set up the building for possession. These steps comprise of the signing of documentation and paperwork, and the release of final reimbursement to the contractor. Closing included the formal acceptance of the project and ending thereof (Harris *et al*., 2006; Ikupolati & Olaleye, 2016).

20.7.12 Feedback stage

Feedback is the furnishing of information concerning an operation. It is an effective management tool because it serves as a source of information that enhances an individual's work performance and is an important process that affects productivity of construction organisations. Construction projects everywhere are prone to problems of communication and a great deal of effort has gone into ways of improving communication by using Feedback tool.

20.8 Cost Control Terminologies

The terms used in cost control are:

i. **Element:** It is a component or part of a building which fulfils a specific function irrespective of its design, specification or construction. Examples are doors, roofs, foundation, column and beam among others.

ii. **Cost Control:** All methods of controlling the cost of building projects within the limit of a pre-determined sum throughout the design and construction stages.
iii. **Cost Planning:** It is a process of controlling the cost of a project within a pre-determined sum during the design stage. The process here includes the cost plan and cost check.
iv. **Cost Plan:** It is a statement related to a definite standard of quality of each section or element of a new building.
v. **Cost Check:** It is the process of checking the estimated cost against the cost target set against an element or section of a building in cost plan as the detail design emerges.
vi. **Approximate Estimating:** A process of forecasting or computing the probable cost of a project before the preparation of the Bill of Quantities.
vii. **Cost Analysis:** It is the systematic breakdown of the cost of a project, usually on elemental basis.
viii. **Cost Research:** This involves all methods of investigating building cost and their relationship including maintenance and running costs in order to make planning and control of the cost of future project easy.
ix. **Cost-in-Use:** An investigation in to the total cost of a project throughout its expected life span. This includes initial capital cost, maintenance cost and running cost.
x. **Cost Study:** It is a basic investigation or research in to the various cost planning and control techniques in order to identify the best option to be adopted at a particular point in time.
xi. **Investment Appraisal and Analysis:** This is used to select the most economic project to be embarked upon.

CHAPTER TWENTY-ONE

COST PLANNING THEORY

21.1 Introduction

Cost planning theory will be discussed under two major headings. These are "Cost Analyses" and "Cost Planning". This is because the theory is basically on the basis of elemental and comparative cost approach.

21.2 Principles of Cost Analysis

Cost analysis is the systematic breakdown of building costs, in accordance with the sources from which they have been derived. The purpose of cost analysis is to provide the Quantity Surveyor with data which will allow comparison to be made between the cost of achieving the various building functions in one project with that of achieving equivalent functions in another project. The comparisons are usually carried out on the basis of building elements.

Elemental costs are usually related to square metre of gross internal floor area in addition to a parameter that is closely identifiable with the element such as the element's quantity units. The cost analysis allows for varying degree of details throughout the evolution of the design process. For example, broad costs are needed during the initial stage of the design but as the design progresses more detailed information are needed. Analyses of similar type and size of buildings vary considerably and a careful study is essential before they are to be used for cost planning.

Cost Analysis can be classified according to grouping of items. Two of such classifications using the trade and elemental methods of project breakdown are as presented in Table 21.1.

Table 21.1: Classification of Works for Cost Analyses

S/NO.	CLASSIFICATION BY TRADE	CLASSIFICATION BY ELEMENT
1	Excavation and Earthwork	Substructure
2	Concrete work	Frames
3	Block work	Upper floors
4	Masonry	Roof

5	Asphalt work	Stairs
6	Roofing	External walls
7	Carpentry and Joinery	Windows and external doors
8	Structural steel work	Internal walls and partitions
9	Metal work	Internal doors
10	Finishes	Wall finishes
11	Painting and decorating	Floor finishes
12	Services	Ceiling Finishes
13	External works	Fittings and furnishings
14		Services
15		External works

An illustrated example (Example 21.1) using a completed project is given below to compare these two classification methods as presented in Tables 21.2 and 21.3 respectively.

Example 21.1

PARTICULARS OF REFERENCE PROJECT

PROJECT: SET Lecture Hall

CLIENT: Federal University of Technology, Minna

CONTRACT SUM: =N= 1,078,038.16

CONTRACT PERIOD: 17 months

TENDER DATE: April, 1990

GROSS FLOOR AREA: 5376 m^2

BRIEF DESCRIPTION: The project consisted of a 250-seat auditorium and a 750-seat amphitheatre with offices, changing rooms and projecting rooms.

FINAL ACCOUNT: =N= 1,009,038.00

EXPLANATORY NOTES

1. **Block Work:**

150mm and 225mm sandcrete hollow block work in cement mortar (1:4).

2. **Roofing:**

i. Canvassing timbers to be pressure impregnated with solignum. Spacing of rafters, purlins and noggins to be 1800mm, 1000mm and 600mm centres respectively.
ii. Roof covering to be light Super 7 corrugated asbestos roofing sheet with 100mm end lap and two corrugations side up.

iii. Ridge capping to be two asbestos cement 600mm girth.

3. Finishings:

Internally

i. Offices

Wall: 12mm smooth rendering and 2 coats of emulsion paint.

Floor: 200 x 200 x 12mm thick ceramic tiles.

Skirting: 25 x 75mm splayed top edge hardwood painted with gloss paint.

ii. Kitchenette:

Wall: 12mm smooth rendering and 2 coats of emulsion paint.

Floor: 50mm thick cement and sand screeded bed to receive 18mm terrazzo finish.

iii. Toilet:

Wall: 150 x 150 x 12mm white glazed wall tiles up to a height of 2100mm. The balance height is to be rendered and painted with 2 coats of emulsion paint.

Floor: 18mm in-situ terrazzo finish on screeded bed.

Externally:

i. Walls: 12mm smooth rendering and 2 coats of emulsion paint on walls.

ii. Ceiling: All ceiling finishings are to be 600 x 600 x 6mm thick Celotex ceiling board and two coats of emulsion paint.

Table 21.2: Classification by Trades

TRADE	TRADE COST (=N=)	COST/m^2 GFA (=N=)	% OF TOTAL COST (%)	TRADE QUANTITY (m^2)	TRADE UNIT RATE (=N=)
Preliminaries	23,200.00	4.32	2.30	-	-
Demolition	-	-	0.00	-	-
Excavation and Earthwork	65,709.46	12.22	6.51	2375.00	27.67
Piling	-	-	0.00	-	-
Underpinning	-	-	0.00	-	-
Concrete work	276,877.19	69.83	26.55	2304.00	116.27
Block work and Brick work	722.84	0.13	0.07	212.00	3.41
Masonry	-	-	0.00	-	-
Asphalt work	-	-	0.00	-	-

Roofing	18,953.80	3.53	1.88	2380.00	7.96
Carpentry and joinery	39,180.70	7.29	3.88	-	-
Structural steel work	12,936.15	2.41	1.28	-	-
Metal work	103,598.30	19.27	10.27	-	-
Floor, wall, ceiling finishes	43,075.89	8.01	4.27	3036.00	14.18
Glazing	962.53	0.81	0.10	180.00	5.35
Painting and decorating	21,442.48	3.99	2.13	1169.00	18.34
Plumbing	17,459.60	3.25	1.73	-	-
Mechanical Engineering work	110,695.20	20.59	10.97	-	-
Electrical installation	206,870.60	38.48	20.50	-	-
Drainage	17,766.76	3.30	1.76	-	-
Site work	4,616.34	0.86	0.46	-	-
Contingencies	53,973.36	10.04	5.35	-	-
TOTAL	**1,009,038.20**	**197.69**	**100.00**	**-**	**-**

Table 21.3: Classification by Elements

TRADE	TRADE COST (=N=)	COST/m² GFA (=N=)	% OF TOTAL COST (%)	TRADE QUANTITY (m²)	TRADE UNIT RATE (=N=)
Preliminaries	23,200.00	4.32	2.30	-	-
Substructure	65,709.46	12.22	6.51	2375.00	27.67
Frame	126,952.72	23.61	12.58	-	-
Upper Floors	35,952.44	6.69	3.56	2748.00	13.08
Roofing	30,764.99	5.72	3.05	2380.00	12.93
Stairs	18,630.89	3.47	1.85	-	-
External Walls	98,859.02	18.39	9.80	4068.00	24.30
Windows and External Doors	10,934.82	2.03	1.08	-	-
Internal Walls and Partitions	15,592.01	2.90	1.55	1283.00	12.15
Internal Doors	10,206.56	1.90	1.01	-	-
Wall finishes	21,169.56	3.94	2.10	4600.00	4.60
Floor Finishes	34,307.51	6.38	3.46	5.15	6.71
Ceiling Finishes	11,558.48	2.15	1.15	4639.00	2.49
Fittings and Furnishings	67,035.55	12.47	6.64	-	-
Services	361,807.73	67.30	35.86	-	-
External Works	22,383.10	4.16	2.22	-	-
Contingencies	33,973.36	10.04	5.35	-	-
TOTAL	**1,009,038.20**	**187.69**	**100.00**	**-**	**-**

The method of comparative cost analysis can be used to highlight the different features of past projects and thereby identify adjustments for future projects. This is illustrated for two projects x and y below respectively (Example 21.2).

Example 21.2

PRELIMINARY INFORMATION

Type of Building: Office Block
Gross Floor Area: 3869m^2
Date of Tender: November, 1991
Location: Minna

Table 21.4: Information on Projects X and Y

No.	Element	Cost of Element per sq. m GFA (=N=)		Comments
		Building x	Building y	
1	Substructure	15.00	21.00	Building x is on a reasonably good soil and has reinforced concrete column bases and ground beams.
2	Frame	15.75	18.50	Building x has a reinforced concrete while Building y is steel framed.
3	Upper Floors	7.50	13.50	Half of Building x floor area is on the ground floor while about 30% of Building y floor area is on the ground floor.
4	Roof	14.80	13.00	Building x has greater roof area covering of felt. Building y is covered with Asphalt.
5	Staircases	5.50	10.50	More elaborate balustrades and two extra storey flights of stairs for Building y.
6	External Walls	4.60	7.10	Building x is regular shape. Building y is a more irregular shape and increased height.
7	Windows	2.30	5.10	The windows in Building x are mainly standard type. Building y has special windows, some of which are double glazed.
8	External Doors	1.00	3.55	Building x has cheap doors and frames.
9	Internal Load Bearing Walls	1.60	1.75	Most of the internal divisions are non-load bearing for Buildings x and y.
10	Partitions	1.00	2.50	Only the main divisions are provided in Building x.
11	Internal Doors	1.00	3.50	Only a few cheap doors in Building x.
12	Ironmongery	0.70	1.75	More doors and better-quality ironmongery in Building y.

13	Wall Finishes	1.30	3.70	The walls in Building x are mostly rendered. Building y has paneling provided in the executive suite and marble and mosaic in the entrance hall.
14	Floor Finishes	5.00	13.50	Mainly thermoplastic tiles in Building y include a variety of different finish such as quarry tiles and vinyl tiles.
15	Ceiling Finishes	1.75	6.75	Building x has rendering on to the concrete structure. Building y has suspended ceilings.
16	Decoration	2.10	2.35	Emulsion is used on most of the ceilings and walls in both cases.
17	Fittings	3.00	6.75	Only essential fittings are provided in Building x but in Building y most of the main fittings are included.
18	Sanitary	1.50	3.40	Building y has more and better fittings.
19	Waste Soil and Air-conditioning	1.50	1.55	Same level of fittings.
20	Cold Water Services	1.60	1.65	Same level of fittings.
21	Ventilation and Air-conditioning	5.00	8.70	Building x has unit air-conditioners. Building y has split units.
22	Electrical Installation	10.00	21.00	Essential fittings only are provided in Building x whereas Building y has elaborate fittings arrangement.
23	Fire Fighting Equipment	2.10	2.15	Same level of protection.
24	Drainage	1.70	2.50	Sanitary fittings more dispersed in Building y.
25	External Works	10.00	22.00	More work for Building y.
26	Preliminaries	15.00	16.00	
27	Contingencies	20.00	25.00	
	TOTAL	**=N= 152.30**	**=N= 238.75**	

Solution/Computation:

Application of Cost Analysis

Proposal:

4 storey office building (for letting) of regular shape.

Location of Project:	Kano
Anticipated Date of Commencement:	August, 1994
Floor Area:	4080m^2

Analysis:

5 storey irregular shaped office block.

Date of Tender:	November, 1991
Location of Project:	Kaduna
Floor Area:	3869m^2

Price Adjustment:

(1) General Market Level

Using Cost Indices

Index at November 1991	=	225
Index at December 1993	=	405
Assess to August 1994		
Allow 5%	=	20
Total Index at August '94	=	425

Increase from November 1991 to August 1994

$$= \frac{425 - 225}{225} \times \frac{100}{1} = \mathbf{88.89\%}$$

(2) Particular Conditions

i. Site
ii. Construction (general) } say 10% = 8.89%
iii. Location

General Price Increase = 80%

(3) Price and Design Risk

Inflation to tender date (August, 994)
Fluctuating contract, and
2-year contract period = $\frac{2 \times 30\%}{2}$

= 30%

Design Risk	=	3%
Contingencies		5%
Total Additions	**=**	**38%**

Project:	Office Block, Kano	Estimate No. 1
GFA:	$4080m^2$	Page No. 1
Date:	17/08/94	Basis: C.A.

Table 21.5: Summary of Omissions and Additions

Ref	**Omissions**		**Ref**	**Additions**	
	Detail	**/m²**		**Detail**	**/m²**
1	Substructure Underpinning not required =N=1170/3869m² Piling not required =N=11,000/3869m²	0.30 2.84	1	Substructure Additional cost in increasing, design of foundation bases and ground beams (=N=3,500) =N=3,500/4080m²	0.86
2B	Upper Floor Omit Complete	8.06	2B	Upper Floors Nom. Sup. Quotation for: PC Floor Units =N=17,500 Gen. Cont. =N=5,000 Ancillary =N=2,500 Total =N=25,000 =N=25,000/4080m²	6.13
2C	Roof Omit Complete	6.71	2C	Roof Nom. Supplier = =N=7,750 Gen. Cont. & Fixg = =N=2,500 Total = =N=10,250 =N=10,250/4080m² = 2.51 Add: Allowance for screeded asphalt and trimming to roof. (1020 x 15.25)/4080m² = 3.81 2.51 + 3.81 =6.32	6.32
2E	External Walls Ashlar Facing =N=8,250/3869m²	2.13	2E	External Walls Replace Ashlar with facing bricks. (225m² x =N=18)/4080m²	0.99
2G	Internal Walls Open Plan Omit Int. Ptns. 3.62 x 85%	3.08	2G	Not applicable	
4A	Fittings Elevated Link =N=2,000 Kitchen Equip. =N=10.000 Total = =N=12,000 =N=12,000/3869m²	3.10	4A	Not applicable	
5K	Protective Installation Omit Complete = 0.93 Bwk. 9.23% = 0.09	1.02	5K	Protective Installation Add Quote for sprinkler system. =N=12,800 Bwk. 9.23% =N=1,184 Total = =N=13,984 =N=13,984/4080m²	3.43

5L	Communication Installation Omit Complete = 0.13 Bwk. 9.33% = 0.01	0.14	5L	Not applicable	
	TOTAL OMMISSIONS NOVEMBER, 1991	**27.38**		**TOTAL EXPENDITURE (Current Prices)**	**17.73**

Table 21.6: Summary of Cost Analysis

	TOTAL COST ANALYSIS (EXCL PRELIMS	197.75
OMIT	OMISSIONS (EXCL PRELIMS)	= 27.38
ADD	PRICE ADJUSTMENTS	170.37 80% = 136.30
ADD	ADDITIONS	= 306.67 17.73
ADD	PRICE AND DESIGN RISK	= 324.40 38% = 123.27
ADD	PRELIMINARIES	447.67 10% = 44.77 TOTAL = 492.44
	TOTAL FEASIBILITY COST $4080m^2$ X =N=492.44	**=N= 2,009,155.20**

Example 21.3

Question:

Your firm of Quantity Surveyors is currently preparing a cost plan for a building using the Architect's sketch and design criteria provided hereunder:

Design Criteria

Proposed building is 30.00m long x 22.00m wide with a total height of 9.00m (three storey building).

Building cost index for the existing structure = 185

Projected index at date of tender for the new structure = 215

External: wall 225mm Block wall

Roof: concrete roof

Staircase: reinforced concrete with metal balustrade and hardwood rail straight flight

Upper floors: reinforced concrete floor

Analyzed Data:

Gross floor area = $1300m^2$

	Total cost (=N=)	Cost/M^2
GFA (=N=)		
External Wall (225mm Block wall)	1,620,000	1,246.20
Roof (R.C., 150mm thick)	1,500,000	1,153.85
Staircase (Concrete, straight flight)	620,000	477.00
Upper floors (R.C., 150mm thick)	3,500,000	2,692.31

External Wall/GFA ratio = 0.46
Roof Area = $650m^2$

Assume that the contract particulars and geographical location of the new and existing buildings are the same.

Calculate the projected total element cost for the following, stating clearly all assumptions made:

a) External walls
b) Roof
c) Staircase
d) Upper floors

Solution:

Data:

Existing Building

GFA = $1300m^2$
External Wall/GFA ratio = 0.46
Roof Area = $650m^2$
Cost Index = 185

Computation:

Proposed Building

GFA = 30.00m x 22.00m = **$660m^2$**
External Wall/GFA ratio = 2(30.00+22.00)/660
= 2(52)/660 = 104/660 = **0.16**

Roof Area = If existing building has $650m^2$ (i.e., half the GFA) has the roof area and both buildings have similar contract particulars, then the roof area to the proposed building will be half its GFA ($660m^2$).

Hence;

Roof Area = $660m^2/2$ = **$330m^2$**
Cost Index = **215**

ADJUSTMENT FACTORS:

General Market Level (Cost Index [C.I.])

Change in C.I. = [(Present Index – Previous Index)/Previous Index] x 100%

= [(215 – 185)/185] x 100%

= (30/185) x 100%

= 0.16216 x 100%

= **16.22% (To be used to update market price for all elements)**

Design Consideration

Change in Ext Wall/GFA Ratio (EWGR) = [(Present EWGR – Previous EWGR)/Previous EWGR] x 100%

= [(0.16 – 0.46)/0.46] x 100%

= [(- 0.30)/0.46] x 100%

= - 0.652 x 100%

= - 65.22% (Adjustment factor for costs of walls. Floors, and staircase)

Change in Roof Area = [(Present Roof Area – Previous Roof Area)/Previous Roof Area] x 100%

= [(330 – 650)/650] x 100%

= (- 320/650) x 100%

= - 0.492 x 100%

= - 49.23% (Adjustment factor for cost of roof)

PROJECTED ELEMENTAL COSTS:

External Walls

Table 21.7: Projected Cost for Elements (Raw Calculations)

Item No.	**Element**	**Existing Cost/m² (=N=)**	**Adjustment Factor 1 (%)**	**Computation**	**Adjustment Factor 2 (%)**	**Computation**	**Proposed Cost/m² (=N=)**
a)	External Walls	1,246.20	**- 65.22**	1246.20 + [(-65.22/100) x 1246.20] = 1246.20 – 816.88 = **=N=429.32**	**16.22**	429.32 + [(16.22/100) x 429.32] = 429.32 + 69.64 = **=N= 498.96**	**498.96**
b)	Roof	1,153.85	**- 49.23**	1153.85 + [(-49.23/100) x 1153.85] = 1153.85 – 568.04 = **=N=585.81**	**16.22**	585.81 + [(16.22/100) x 585.81] = 585.81 + 95.02 = **=N=680.83**	**680.83**
c)	Staircase	477.00	**- 65.22**	477.00 + [(-65.22/100) x 477.00] = 477.00 – 311.88 = **=N=165.90**	**16.22**	165.90 + [(16.22/100) x 165.90] = 165.90 + 26.91 = **=N=192.81**	**192.81**
d)	Upper floors	2,692.31	**- 65.22**	2692.31 + [(-65.22/100) x 2692.31] =	**16.22**	936.38 + [(16.22/100) x 936.38] =	**1,088.26**

				2692.31 – 1755.93 = **=N=936.38**		936.38 + 151.88 = **=N=1,088.26**	

Table 21.8: Summary of Elemental Cost

Item No.	**Element**	**Proposed Cost/m² (=N=)**	**GFA (m²)**	**Computation of Total Cost**	**Total Cost (=N=)**
a)	External Walls	498.96	660	498.96 x 660	329,313.60
b)	Roof	680.83	660	680.83 x 660	449,347.80
c)	Staircase	192.81	660	192.81 x 660	127,254.60
d)	Upper floors	1,088.26	660	1,088.26 x 660	718,251.60

Table 21.9: Summary of Total Elemental Cost for Proposed Building

Item No.	**Element**	**Total Cost (=N=)**	**Cost/m² (=N=)**
a)	External Walls	329,313.60	498.96
b)	Roof	449,347.80	680.83
c)	Staircase	127,254.60	192.81
d)	Upper floors	718,251.60	1,088.26
	Total (=N=)	**1,624,167.60**	**2,460.86**

21.3 Cost Planning Theory

One of the short-coming of approximate estimating is that it lacks effective cost control, as the detailed design develops. To overcome this unnecessary defect, cost planning evolved as a technique whereby the original estimate can be prepared on the basis of known and economic standard of construction and finishes. In addition, the estimate can be constantly monitored against the working drawings and provisions for necessary adjustments. By the time the project goes out of tender, the probable cost would have been determined to/within close limits, and during the progress of the work, the monitoring of cost can continue until the end of execution. Cost planning is therefore the technique employed to keep the total cost of construction within the limit of a predetermined sum during the design stage of a project. There are essentially two main methods of cost planning which are in use in the construction industry. These are the elemental and the comparative cost planning methods.

21.3.1 Elemental Cost Planning

The elemental cost planning method is based on the proposition that the client is not only able to set a cost limit to the amount of money that he wishes to spend on a particular project, but he is also willing to agree to the expenditure of a fixed amount to provide a certain quantity of functional accommodation. Under this method, a target cost is agreed upon for the entire scheme, which may then be divided into separate sub-targets for individual elements that make up the works to be executed.

The task of the members of the design team, particularly the Quantity Surveyor, during the design process will be to adjust the quantity and quality of the various elements to meet the cost limit. By this approach, each element of the building can be considered against a set target so as to ensure a balance between the different parts of the scheme to meet the overall expenditure proposal. It must be emphasised that although this system will allow good buildings to be produced within the limited budget, it is however not primarily designed to produce the cheapest possible scheme. In this regard, the intention of elemental cost planning is to provide a building that satisfies all the requirements of the client at an agreed cost limit. The format of an elemental cost plan is as shown in Table 21.10.

Table 21.10: Format of an Elemental Cost Plan

Element	**Total Cost (=N=)**	**Cost/m^2 GFA (=N=)**	**% of Element (%)**
Preliminaries	30,000.00	80.00	9.68
Substructure	46,550.00	124.13	15.02
Frames	85,669.00	228.45	27.66
Roof	21,705.00	57.88	7.01
Upper Floors	31,649.00	84.40	10.22
Walls	25,145.74	67.06	8.12
Services	30,477.40	81.27	9.84
External Work	18,575.15	49.53	6.00
Contingencies	20,000.00	53.33	6.46
TOTAL	**309,772.00**	**826.06**	**100.00**

The application of elemental cost plan is often a straight-forward exercise as the various elemental costs of a previous project act as a reference point for establishing cost target for a proposed project. It may be possible to apply a percentage adjustment to the historical data to enable the design team work on a cost limit as shown Table 21.11. The overall effect of the adjustment on the original aggregate cost limit amounts to =N=50,913.60 or approximately 18 per cent.

Table 21.11: Cost Plan for Proposed Office Accommodation

Element Grouping	Base Cost Data (=N=)	Adjustment Factor (%)	Cost Limit (=N=)
Substructure	46,550.00	+ 50	69,825.75
Frames	85,669.15	+ 10	94,236.07
Roof	24,705.19	-15	18,449.30
Upper Floors	31,649.45	+ 25	39,561.81
Walls	25,145.74	-10	22,631.17
Services	30,477.40	+ 30	39,620.62
External Work	18,575.15	+ 15	21,361.42
Contingencies	20,000.00	+ 25	25,000.00
TOTAL	**279,772.54**		**330,686.14**

21.3.2 Comparative Cost Planning

The comparative cost planning method assumes a framework of initial feasibility and cost study to determine the general lay out and arrangement of the building in the light of its overall cost target. In this instance there is usually no target for individual elements. The study of alternative proposals takes account of all the consequential effects of decisions on various parts of the building. The information on each proposal is set out in a manner which enables the design team to make decision with respect to individual cost and their cumulative effect on total cost during the design process, in terms of financial, functional and aesthetic considerations. The particular proposal that has been selected becomes the operational basis for further design work for working drawings and specification writing. The Quantity Surveyor will need to carry out periodic cost checks throughout the design stage to ensure that the design proposals are being kept within the cost limit approved by the building client. The major difficulty in this method of cost planning is associated with the volume of abortive work that may have to be undertaken by the Quantity Surveyor in the process of arriving at an acceptable option. The final solution will be a compromise of trade-offs between the different alternatives. Table 21.12 is a matrix of comparative cost planning method.

Table 21.12: Matrix of Comparative Cost Planning Method

Element	**Alternative Solutions**				**Acceptable Option**
	1	**2**	**3**	4	
Substructure	*	*	-	-	2
Frames	*	*	*	-	3
Roof	*	*	-	-	2
Upper Floors	*	*	-	-	1
Walls	*	*	-	-	1
Finishes	*	*	*	-	2
Electrical Installations	*	*	-	-	1
Sanitary and Water Supply	*	*	-	-	2
External Works	*	*	-	-	2
Contingencies	*	*	-	-	1

Once the alternative solutions for entire project have been decided, the next step involves the computation of the sub-targets using traditional methods of estimating. However, it is pertinent to know that other consultants such as Architect and Engineers will make significant contributions towards the choice of an acceptable option for the individual elements and hence the final cost. By the time the Quantity Surveyor has completed a cost plan for a comparative cost planning approach, the format could be of the form shown in Table 21.13:

Table 21.13: Cost Plan for Comparative Cost Planning

S/N	**Element**	**Alternative Solutions (=N=)**			
		1	**2**	**3**	4
1	Substructure	315,755.00	480,750.00	-	-
2	Frames	1,556,715.00	1,475,000.00	1,875,000.00	-
3	Roof	565,447.00	475,000.00	-	-
4	Upper Floors	756,228.00	680,195.00	-	-
5	Walls	915,616.00	751,175.00	-	-
6	Finishes	1,816,359.00	1,765,200.00	1,700,000.00	-
7	Electrical Installations	2,500,000.00	3,000,000.00	-	-
8	Sanitary and Water Supply	650,000.00	785,000.00	-	-

9	External Works	300,000.00	250,000.00	-	-
10	Contingencies	200,000.00	150,000.00	-	-

The final estimate will then be obtained as shown in Table 21.14.

Table 21.14: Estimate of Comparative Cost Plan

S/N	Element	Amount (=N=)
1	Substructure	480,750.00
2	Frames	1,875,000.00
3	Roof	475,000.00
4	Upper Floors	765,228.00
5	Walls	915,616.00
6	Finishes	1,765,200.00
7	Electrical Installations	2,500,000.00
8	Sanitary and Water Supply	785,000.00
9	External Works	250,000.00
10	Contingencies	200,000.00
	Total	**10,002,794.00**

The essential difference between the elemental and comparative cost planning methods is that in the former case, the design evolves over a period of time within the agreed cost target; in the latter case, the design is fairly established as early as the sketch plan stage, after the choice of various alternatives has been made, and is not in most instances altered after this stage. While the elemental system has been described as 'designing to cost', the comparative system is usually referred to as 'costing a design'.

21.4 Phases of Cost Planning

Cost planning has three phases. These are: Phase 1 (Estimate; calculation of the cost limit); Phase 2 (Cost Plan); and Phase 3 (Cost Check). Cost plan and cost check have been discussed earlier in the previous Chapter. The estimate phase will be discussed in detail under a full Chapter.

CHAPTER TWENTY-TWO

METHODS OF ESTIMATING COST OF CONSTRUCTION WORKS

22.1 Introduction

The Estimate is the first phase of Cost Planning where calculations of the cost limit are carried out using various estimating techniques or methods. These methods are discussed in the following sections.

22.2 Approximating Estimating Techniques

The following methods are used under the approximate estimating techniques:

1) Unit Method
2) Superficial/Floor Area Method
3) Cubic Method
4) Storey Enclosure Method

22.2.1 Unit Method

The Unit Method of approximate estimating seeks to allocate cost to each accommodation unit of the particular building be it per person, seats, beds and car spaces among others. The total estimated cost of the proposed building is then determined by multiplying the total number of units accommodated in the building by the unit rate. The procedure for the application of unit rate is straight-forward, as it does not involve the preparation of drawings. The information needed are assessed from the following:

- The number of units or persons to be accommodated.
- The unit rate that will be applied.

22.2.2 Superficial or Floor Area Method

This is a single rate method which has become most popular method of estimating during the early design stage of a project. This method should not be used later than the outline proposal stage. The procedures for the application of the superficial or floor area technique are:

- Measure gross internal floor area of building.
- Apply selected rate per metre square of building.
- Adjust for items not included in rate.

22.2.3 Cubic Method

The Cubic Method, which is also a single rate method of approximate estimate, was used quite extensively between the wars but has since been largely superseded by the superficial or floor area method, hence the cube method is now considered to be obsolete. The rules commonly followed in computing the cubic content of a building are:

- The plan measurements are taken to the external faces of the external walls.
- The height of the building is to be taken from half way up a pitched roof and 600mm above a flat roof.

This method should not be used later than the outline proposal stage. The above procedure for the application of the cubic technique can be further broken down as given below:

1. Measure the cubic volume of the building by taking:
    a) Gross external plan area of building
    b) Height of building from top of foundation to either 600mm above a flat roof or mean height of pitched roof.
2. Apply selected rate per metre cube of building
3. Adjust for items not included in rate.

22.2.4 Storey Enclosure Method

This is also a single rate method which was developed in the 1950s to overcome the difficulties of adjusting for quantity variations encountered with the cubic and superficial/floor area methods. Application of the Storey Enclosure Method involves the following factor adjustments:

- Floor areas are measured from the inner faces of external walls. Basement floors are weighted by a factor of 3.00, ground floor by a factor of 2.00, upper floors are subsequently weighted with a factor increasing by the value of 0.15 i.e., 1st floor = 2.15, 2nd floor = 2.30, 3rd floor = 2.45, 4th floor = 2.60, etc.

- Roof areas are measured on plan to the extremities of eaves.

- External wall areas are measured on the external face of the wall with no deduction for openings. Basement walls are weighted by a factor of 2.00.

- The sum of these weighted areas, known as storey enclosure units, is multiplied by an established single rate to obtain the established single rate to obtain the estimated cost of the project.

The procedure for the application of storey enclosure method as detailed above is summarized below:

1. Evaluate Storey Enclosure Unit by computing:
    a) Internal floor areas and weighting factor.
    b) Roof area.
    c) External Wall area with weighting factor.
2. Apply selected rate per storey enclosure unit.
3. Adjust for items not included in rate.

22.3 Comparative Estimate Method

This method of estimating is to take the known cost of a similar type of building as a basis and then to make cost adjustments for variations in constructional methods and materials.

22.4 Interpolation Method

This is a variant of the comparative method whereby at the brief and investigation stages in the design of a project, an estimate of probable cost is produced by taking the cost per square metre of floor area of a number of similar type of buildings from cost analysis and cost records and interpolating a unit rate for the proposed building.

22.5 Elemental Estimating Method

This method evolved initially from the storey enclosure technique where the various elements are considered separately for quality and quantity adjustments. The method is not a single rate method. The cost data required to produce an estimate is obtained from cost analysis of previous projects.

22.6 Approximate Quantities Method

This method is regarded as the most reliable method of preparing estimate provided the required detailed information is available. Its popularity lies in the use of traditional taking-off procedures and composite rates obtainable from Bills of Quantities. Cost data can also be obtained from cost analysis and price books. The approximate quantities method is a simplified method of taking-ff. the method is often not in use in the estimate stage. It is used in the cost checking as by this stage detailed Drawing would have been provided.

22.7 Advantages and Disadvantage of Estimating Methods

Below are the main advantages and disadvantages of estimating methods:

22.7.1 Unit Method

Advantages:

1. It can be used to indicate the likely cost range of project before any Drawing is made available by the Architect and other engineering consultants.
2. It can be used to facilitate comparison between buildings to indicate whether the cost of a project is reasonable in relation to buildings of similar usage.

Disadvantages:

1. It cannot be used to estimate the cost of a specific building as adjustments cannot be accurately made to the applied rate.
2. Items not normally included in the unit cost such as external works and abnormal costs will have to be assessed separately.

22.7.2 Superficial or Floor Area Method

Advantages:

1. The accuracy of measurement is meaningful to the Architect and Client and the preparation is usually simpler than the cube method.
2. Most published information on building costs are expressed in terms of the cost per square metre of gross floor area of the building.

Disadvantages:

1. The accuracy of this method depends on the use of rates based on projects of similar storey heights, sizes, plan shape and form of construction.
2. Care should be taken in determining what must be included in the rate. Additional items such as external works and services and abnormal costs would have to be estimated separately using different price rates.

22.7.3 Cube Method

Advantages:

1. The method is relatively quick and simple to use as it gives some indication of likely cost.
2. It is possible for the computed cubic content to be used in assessing air-conditioning requirement and fire insurance premiums by insurance companies.

Disadvantages:

1. The unit of measurement is highly artificial and the single rate is difficult to adjust in cases of significant variations in quality of project.
2. The method does not take account of quantity variations, which may occur in horizontal components of the building.
3. Care should be taken in determining what items are included in the rate adopted. Additional item must be measured separately e.g., lifts, electrical works, air-conditioning, external works, etc.
4. Due to large number of units, the rate used will need to be more accurate as small errors could become significant on extension.
5. Where a project comprises two or more user categories, the volumes as well as rates will have to be assessed separately

22.7.4 Storey Enclosure Method

Advantage:

The main advantage is the understanding that the estimate produced includes a form of adjustment for plan shape, size, vertical positioning of areas within the building, storey height and basements.

Disadvantages:

1. Quality adjustments are difficult to assess.
2. All quality adjustments are not automatically accounted for by this method.
3. The measurement unit produced is not definitive and is not understood easily by the Architect or Client.
4. When compared with other single rate methods, more calculations are required.

5. Rates are not readily available to use for producing this type of estimate and considerable time is required in order to prepare suitable rates from previous projects.
6. The estimate produced relates only to the structure and finishes. Electrical, mechanical and plumbing services, external works and other items, which are not included, will have to be assessed separately.
7. A project comparing two or more user groups will have to be assessed separately.

22.7.5 Elemental Estimating Method

Advantages:

1. The method is reliable can easily be understood by all parties.
2. Comparisons are quickly carried out and each element can be adjusted independently.
3. It allows the design team to obtain likely costs and cost implications during the early design stages.
4. Cost data in the form of cost analysis is readily available from a variety of sources.
5. This method provides the basic estimating technique used for most cost planning techniques and analysis.

Disadvantages:

1. The method is time consuming when compared with other methods previously described. Skill is required if elements are to be adjusted accurately.
2. Elements like external works and services have to be assessed separately.

22.7.6 Approximate Quantities Method

Advantages:

1. The method is reliable provided the information is available.
2. Adjustments are simultaneously made in the measurements for changes in plan shape, storey heights and other quantity factors.
3. Quantity adjustments are made by adjustment of the applied rates.
4. The method is used for estimating external works and services on most methods and for the preparation of comparative cost plans and cost checks.

Disadvantages:

1. The method is time consuming and due to the natural evolution of design; it could be inaccurate if prepared too early or late (if delayed until details are available).
2. The method is not suitable for work which cannot normally be measured. Accuracy of this method depends on the use of rates based on projects of similar storey heights, sizes, plan shape and form of construction.
3. Care should be taken in determining what must be included in the rate. Additional items such as external works and services and abnormal costs would have to be estimated separately using different price rates.

22.8 Worked Examples on Estimating Methods

22.8.1 Unit Method

Question:

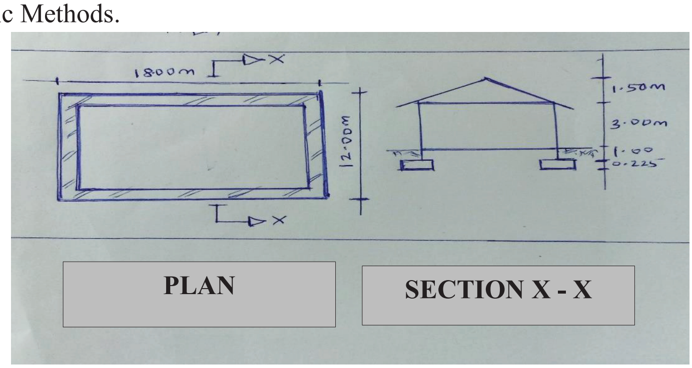
Calculate the cost of a building measuring 25m x 15m internal dimension on plan using the unit method of Approximate Estimating. The building is to accommodate 125 persons at the rate of =N= 26,000.00 per person.

Solution:

Number of persons to be accommodated = 125
Cost of Accommodation per person = =N=26,000.00 -------------- x =N=26,000
Estimated cost of Building = =N=3,250,000.00

22.8.2 Superficial/Floor Area and Cubic Methods

Use the drawings below to answer each of the questions on Superficial/Floor Area and Cubic Methods.



22.8.2.1 Question on Superficial/Floor Area Method

With the use of the building sketch above, calculate the probable cost of building project with the aid of the superficial/floor area method of approximate estimating at a rate of =N=15,650.00/m^2. Cost of items not included in the rate should be taken as 7.5% of the sub total cost of Work.

Solution:

Area of Building = Length x Width
= (18.000 – 0.450) x (12.000 – 0.450)
= 17.55 x 11.55
= 202.70m^2

Area = 202.70m^2 @=N=15,650.00/m^2	=	=N= 3,172,255.00
Cost of items not included in rate:		
7.5% of =N=3,172,255.00	=	=N= 237,919.13
Estimated Cost of Project	=	=N= 3,410,174.13

22.8.2.2 Question on Cubic Method

With the use of the building sketch above, calculate the probable cost of building project using the cubic method of approximate estimating at a rate of =N=2,650.00/m^3. Cost of External Works is estimated as =N=500,000.00 and cost of services as =N=250,000.00.

Solution:

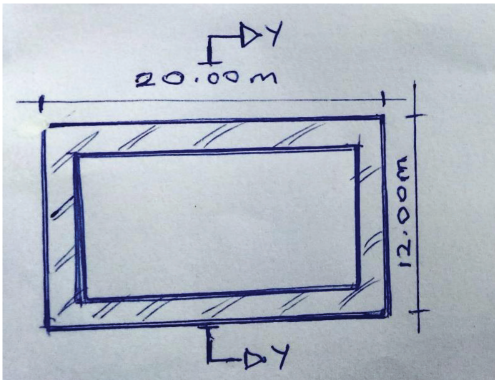
Cubic Volume = Length x Width x Height
Length = 18.00m
Width = 12.00m
Height = [1.00 + 3.00 + (1.5/2)]m = [1.00 + 3.00 + 0.75]m = 4.75m
Cubic Volume = 18.00m x 12.00m x 4.75m = 1,026m^3
@=N=2,650.00/m^3 x 2,650

= Sub Total	=	=N= 2,718,900.00
Estimated cost of external works		=N= 500,000.00
Estimated cost of services		=N= 250,000.00
Estimated Cost of Project		=N= 3,468,900.00

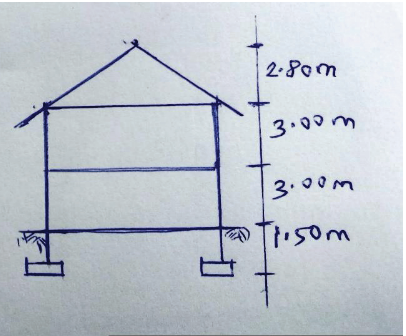
22.8.3 Storey Enclosure Method

Question:

Use the Storey Enclosure Method to estimate the cost of the building sketched below:



PLAN



SECTION Y-Y

<u>NOTE</u>: All dimensions are external dimensions; Walls to ground and upper floors are 225 mm thick.

Solution:

<u>FLOORS</u>

Ground Floor: STOREY ENCLOSURE UNITS

Floor Area = (20.000-0.450) x (12.00-0.450)
= 19.550 x 11.550 = 225.80m^2
x weighting <u>2</u> Storey Enclosure Units = 452

Upper Floor:
Floor Area as Ground Floor = 225.80m^2
x weighting <u>2.15</u> Storey Enclosure Units = 486

<u>ROOF</u>

Roof Area = 21.20 x 13.20 = 279.84 Approx. = 280
No Multiplier Storey Enclosure Units = 280

<u>WALLS</u>

Ground Floor:
Wall Area = (20.000 x 2) + (12.000 x 2) x 3.000
= 192.000m^2
x weighting <u>2</u> Storey Enclosure Units = 384

Upper Floor:
Wall Area as Ground Floor = 192.00m^2
No Multiplier Storey Enclosure Units = <u>192</u>

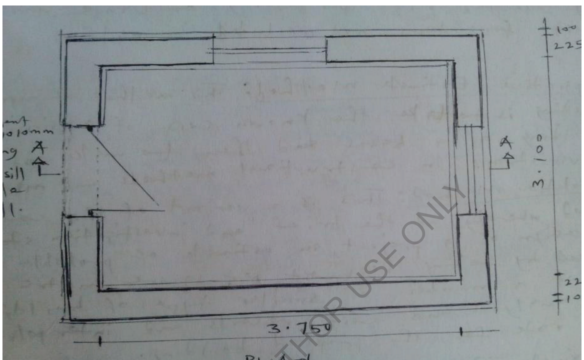
Total Number of Storey Enclosure Units = <u>1794</u>

1794 Storey Enclosure Units @ =N=500	=	=N= 897,000.00
Estimated cost of stairs (Assumed)	=	=N= 95,000.00
Estimated cost of External works (Assumed)	=	=N= 155,000.00
Estimated Cost of Project	=	=N= 1,147,000.00

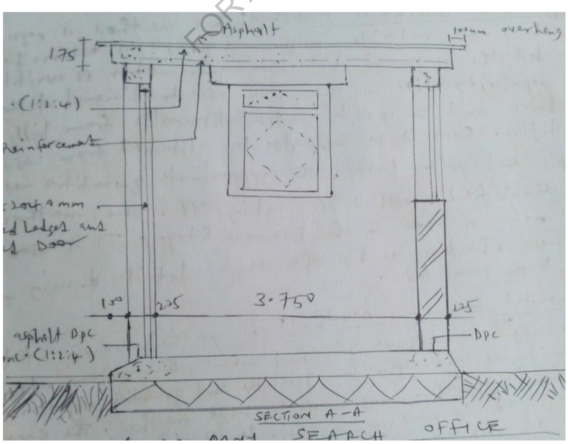
22.8.4 Approximate Quantities Method

Question:

Prepare the Approximate Quantities Estimate for the Search Office Building sketched below.



PLAN



SECTION A-A

A COMPANY'S SEARCH OFFICE

Specifications:

The search office contains the following:

- Metal casement windows 925 x 1010mm (2 Nr.) with concrete roofing tile external sill and quarry tile internal sill.
- 150mm thick (1:2:4) concrete roof slab with fabric reinforcement.
- 826 x 2040mm framed ledged and braced door.

NOTE:

External works are not included in this estimate.

Solution:

Ref No.	Dimension	Extension	Description & Price Build - Up	Qty	Rate (=N=)	Amount (=N=)
			Floor Slab			
			Length Width			
			3.750 3.100			
			Add			
			Walls 2/225 450 450			
			Conc. Proj. 2/100 200 200			
			4.400 3.750			
	4.40					
1	3.75	16.50				
			Excavate oversite, remove surplus soil, lay 150mm bed of hardcore and 100mm bed of concrete (1:2:4) floated to smooth finish and splayed top edge of projecting part of slab.	$17m^2$	1,916.25	32,576.25
			PRICE BUILD UP			
			N : K			
			$1m^2$ excavate oversite &			
			disposal @ $N40/m^2$ = 40.00			
			$1m^2$ of hardcore@$N100/m^2$ = 100.00			
			$0.16m^3$ concrete bed			
			@$N9000/m^3$ = 1440.00			
			$1m^2$ polythene membrane			
			100mm wide @$N220/m^2$ = 220.00			
			1m2 floated finish to			
			concrete @N25/m2 = 25.00			
			N1,825.00			
			Sundry labour 5% = 91.25			
			Cost/m^2 N1,916.25			
			Sum c/f			32,576.25

Ref No.	Dimension	Extension	Description & Price Build - Up	Qty	Rate (=N=)	Amount (=N=)
			Sum b/f			32,576.25
			Walls			
			Length = 3.750 Width = 3.100 2/6.850 Wall Perimeter = 13.700 Add corners 4/225 = 14.600			
2	14.60 3.00	43.80				
			225mm hollow Sandcrete block wall in cement mortar (1:3) laid in stretcher bond, faced externally with facing bricks and flush pointed and two coats of emulsion paint internally.	$44m^2$	2,234.50	98,318.00
			PRICE BUILD UP N : K $1m^2$ of block wall faced externally & flush pointed both sides @N1500/m^2 = 1500.00 $1m^2$ emulsion paint @N180/m^2 = 180.00 $0.5m^2$ DPC @N1000/m^2 = 500.00 =N=2180.00 Sundry Labour 2.5% = =N= 54.00 =N= 2234.50			
			Metal Windows			
3	2	2				
			Extra over cost for window size 925 x 1010mm, including glass painting.	2 Nr.	3,846.83	7,693.65
			PRICE BUILD UP N : K 1Nr. Window & fixing@N3000/Nr = 3000.00 $1m^2$ glass @N1500/m^2 = 1500.00 $2m^2$ painting @N200/m^2 = 400.00 1m conc. roofg. tile sill@N200/m = 200.00 1m quarry conc. tile sill@N200/m = 200.00 2.9m emul. to Reveal @N70/m = 203.00 1.9m facework to reveal @N100/m = 190.00 1.2m concrete lintel @N200/m = 240.00 =N= 5933.00 Sundry labour 2.5% = =N= 148.33 =N= 6081.33 <u>Less</u> 1m2 of blk with finishings =N= 2234.50 Extra cost of window over wall =N= 3846.83			
			Sum c/f			138,587.90

Ref No.	Dimension	Extension	Description & Price Build - Up	Qty	Rate (=N=)	Amount (=N=)
			Sum b/f			138,587.90
			Door			
4						
	1	1	Extra over block wall for framed, ledged & braced door, including frame, painting, face work & concrete lintel.	1 Nr.	4,981.00	4,981.00
			PRICE BUILD UP N : K			
			1 Nr. Door @N5500/Nr. = 5500.00			
			3.4m^2 painting @=N=200/m^2 = 680.00			
			1 pair cross garrets @N200/pair = 200.00			
			1 Nr. Lock @N600/Nr. = 600.00			
			5m frame @N70/m = 350.00			
			10m painting to frame @N70/m = 700.00			
			5m emulsion to Reveal @N70/m = 350.00			
			4m face work to reveal @N100/m = 400.00			
			1.0m concrete lintel @N200/m = 200.00			
			=N= 9000.00			
			sundry labour & cramps 5% = =N= 450.00			
			=N= 9450.00			
			Less 2m^2 of blk wall with fin. = =N=4469.00			
			Extra cost of door over wall = =N= 4981.00			
			Roof			
5	4.40					
	3.75	16.50	Reinforced concrete roof average 162mm thick, reinforced with fabric reinforcement and covered with two coats of asphalt.	17m^2	4,714.50	80,146.50
			PRICE BUILD UP N : K			
			0.16m^3 RC roof slab ave. 162mm @N9000/m^3 = 1440.00			
			1m^2 fabric reinft. @N200m^2 = 200.00			
			1m^2 wrought fm wk to soffit @N650/m^2 = 650.00			
			1m^2 asphalt (2 coats) @N2000/m^2 2000.00			
			1m^2 emulsion paint @N200/m^2 = 200.00			
			=N= 4490.00			
			Sundry items 5% = =N= 224.50			
			Cost/m2 = =N= 4,714.50			
6			Electrical work			25,000.00
7			Telephone work			15,000.00
8			Preliminaries			35,000.00
9			Contingencies			17,000.00
			ESTIMATED COST OF BUILDING			315,715.40

CHAPTER TWENTY-THREE

COST-IN-USE STUDIES

23.1 Introduction

The term cost – in – use, sometimes referred to as ultimate cost or total cost, is a technique of cost prediction by which the initial constructional costs and the annual running costs of a building, or part of a building, can be reduced to a common measure. This is a single sum which is the annual cost – in – use or the present value of all costs over the life of the building. The technique is employed as a design tool for the comparison of the costs of different designs, materials and constructional techniques. It is a valuable guide to the designer in obtaining value for money for the building client. It can also be used by property managers or developers to compare costs against the value accruing from future rents.

23.2 The Concept of Cost – in – use

The traditional approach to cost planning considers only the cost of capital expenditure and it is not usually involved with costs which arise during the life usage of the building. However, for cost planning to be effective and meaningful in any development project, both initial and future costs must be examined in order to assess the real cost of using resources when establishing priorities between competing alternatives.

For comparison of alternative design solutions or proposals it is not adequate to add the face values of various costs incurred from inception and spanning throughout the life of the building. Cost – in – use refers to those costs which the user incurs during the life of the building such as construction, maintenance and servicing, and replacement of major components.

It is now generally accepted that there is need to reduce the overall cost of constructing and operating a building, though a reduction in initial costs often leads to higher maintenance and running costs. It is important to note that maintenance work is highly labour intensive which may result from faulty design and poor workmanship. While maintenance seeks to preserve a building in its life span, there is nevertheless general apathy towards incurring future risks in additional running and maintenance costs. Designers tend to aim at minimum initial cost and; yard-stick seldom take in to account cost – in – use and capital expenditure simultaneously. A full consideration of maintenance aspects and running cost at the design stage is likely to result in a better value for money for the client.

The figure below shows a breakdown of total cost with the object of isolating the significant aspects of future costs in the design process and thus assisting in the search for suitable expressions.

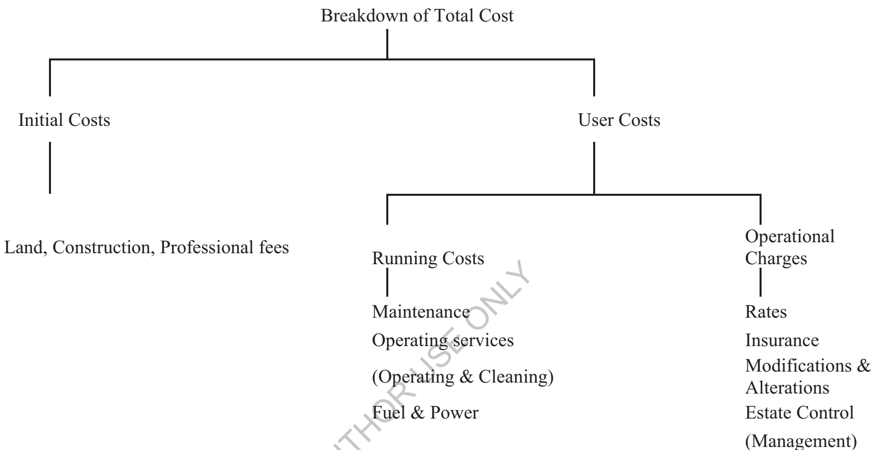


Fig. 23.1: Breakdown of Total Cost
Source: Seeley (1975)

23.3 Definition of Terms in Figure 23.1

i. **Initial Costs:** The capital or initial expenditure on an asset when first provided.

ii. **User Costs:** These are synonymous with future costs and comprise both running costs and occupational charges.

iii. **Maintenance:** Work undertaken in order to keep or restore every facility; that is every part of a site, building and contents, to an acceptable standard.

iv. **Operating Services:** These embrace cleaning, caretaking, operation of plant and equipment and other allied activities.

v. **Fuel and Power:** These represent the energy costs for heating, lighting and air conditioning.

vi. **Modifications and Alterations:** These are new works required to improve or adapt an asset.

23.4 Problems Associated with Cost Assessment

Highlighted below are some of the problems associated with cost assessment:

- ✓ Difficulties of accurately assessing the maintenance and running costs of different materials.
- ✓ Expenditure time scale of initial, annual and periodic items of costs are different and will have to be reduced to a common denominator.
- ✓ Clients involved with investment projects for sale may show little interest in making savings in running costs if these will increase initial costs.
- ✓ The effects of taxation allowance and inflation compound the results of cost – in – use studies.
- ✓ It is difficult to envisage a realistic interest rate for a period of 60 to 80 years duration.

23.5 Problems of Current and Future Payments in Cost – in – use

One of the main problems in making cost – in – use calculations is that most building projects involve different payments over the entire life of the building. These payments include:

- Present payment covering site and building costs, and professional fees.
- Annual payments for rents, lighting, cleaning and minor repairs.
- Periodic payments for repainting, replacement of services and other major parts of the building.

Based on the above, it is necessary to evolve a sound basis incorporating the various costs components of initial costs, periodic and maintenance costs, minor and major repairs, annual running costs and of renewal, so as to permit a reasonable comparison between different designs. This process is referred to as discounting future cost and is based on the premise that if money is not spent on a particular project, then it will be available for other investments or earned interest.

The practical application of cost – in – use studies involves the techniques of present worth values and annual equivalent costs. The present worth approach discounts all future costs at an appropriate rate of interest. On the other hand, the annual equivalent approach attempts to bring the present worth values in to a common factor upon which two or more alternatives can be evaluated on an annual cost incurred. The last approach involves the use of interest rates and sinking fund factor.

23.6 Practical Cost – in – use Examples

Three worked examples are given below to show the application of costs – in – use techniques to design problems involving complete buildings. The first two examples are designed to show the Present Value (PV) and annual equivalent approaches to cost – in – use calculations.

Example 23.1

Question

What is the present value of the running costs of a building with a life of sixty (60) years, given that annual cleaning costs are =N= 40,000.00, annual decorations, =N= 15,000.00 and annual repairs, =N= 10,000.00, external painting, =N= 100,000.00 every five (5) years, and a new roof will be required every thirty (30) years at =N= 1,000,000.00? Interest is to be taken at six per cent (6%).

Solution

		=N= : K
PV for cleaning, decorations and repairs:		
=N=40,000 + N15,000 + =N=10,000 = N65,000 x 16.161	=	1,050,465.00
(PV of =N=1 pa for 60 yrs at 6% = 16.161)		
External painting ---- =N=100,000 x 2.8368	=	283,680.00
(PV of =N=1 at 5 yrs interval at 6% = 2.8368		
(See detailed computation of PVs below)		
Roof replacement ---- =N=1,000,000 x 0.1741	=	174,100.00
(PV of =N=1 in thirty yrs @ 6% = 0.1741		---------------------
PV of running cost	=	**=N= 1,463,245.00**

PV of =N=1 in 5 years at 6%	=	0.7473
PV of =N=1 in 10 years at 6%	=	0.5584
PV of =N=1 in 15 years at 6%	=	0.4173
PV of =N=1 in 20 years at 6%	=	0.3118
PV of =N=1 in 25 years at 6%	=	0.2330
PV of =N=1 in 30 years at 6%	=	0.1741
PV of =N=1 in 35 years at 6%	=	0.1301
PV of =N=1 in 40 years at 6%	=	0.0972
PV of =N=1 in 45 years at 6%	=	0.0727
PV of =N=1 in 50 years at 6%	=	0.0543
PV of =N=1 in 55 years at 6%	=	0.0406

PV of =N=1 @ 5-year interval @ 6% for 60 years	=	**2.8368**

Example 23.2

<u>Question</u>

Find the annual equivalent cost over the life of the building, with an initial constructional cost of =N=10,000,000.00, annual costs of =N=400,000.00 for cleaning and minor repairs, quinquennial repairs of =N=1,000,000.00 and replacement costs of =N=2,000,000.00 every twenty years. The life of the building is to be taken as sixty (60) years and interest at six per cent (6%). Annual sinking fund (ASF) is at three per cent (3%).

<u>Solution</u>

Annual equivalent			=N= : K
Building	=N=10,000,000 x 0.06613		661,300.00
Interest = 6% = 6/100	= 0.06		
ASF for 60yrs @ 3%	= 0.00613		
(Annual Sinking Fund) =	----------------		
	0.06613		

Cleaning and minor repairs ---			400,000.00
Larger repairs ---------- =N=1,000,000 x 2.8368 = =N=2,836,800			
(See detailed computation of PVs in previous page)			
Replacements ---------- =N=2,000,000 x 0.4090 = =N= 818,000			
(0.3118 + 0.0972 = 0.4090)		------------------	3,654,800
To convert PV to annual equivalent;			
Multiply by interest + ASF = 0.06 + 0.00613=		x 0.06613	
		-------------------	241,691.92

ANNUAL EQUIVALENT OF COSTS – IN – USE		**=**	**=N= 1,302,991.92**

Example 23.3

<u>Question</u>

Compare the costs – in – use of the following alternative building schemes:

<u>Scheme A</u>: Total cost of building is =N=5,000,000.00 including Architect's and Surveyor's fees on a site costing =N=1,000,000.00. Annual running costs are estimated at =N=150,000.00. Certain services and finishing will require replacing at a cost of=N=600,000.00 every twenty (20) years. Other services have an estimated working life of thirty (30) years and a replacement cost of =N=800,000.00.

<u>Scheme B</u>: Total cost of building is =N=6,500,000.00 including Architect's and Surveyor's fees on a site costing =N=1,000,000.00. Annual running costs are

estimated at =N=120,000.00. Certain services and finishing will require replacing at a cost of=N=400,000.00 every twenty (20) years. Other services have an estimated working life of thirty (30) years and a replacement cost of =N=500,000.00.
In both cases the estimated life of the building is sixty (60) years. Take an interest rate of six per cent (6%) and an annual sinking fund (ASF) of three (3%).

Solution

Scheme A: =N= : K

Cost of site -- =N=1,000,000
Annual equivalent in perpetuity @ 6% --------- 0.06
60,000.00

Cost of building ------------------------------------- =N=5,000,000.00
First replacement cost in 20 yrs = =N=600,000
PV of =N=1 in 20 yrs @ 6% = x 0.3118
187,080.00

Second replacement cost in 40 yrs= =N=600,000
PV of =N=1 in 40 yrs @ 6% = x 0.0972
58,320.00

Replacement cost in 30 yrs @ 6% = =N=800,000
PV of =N=1 in 30 yrs @ 6% = x 0.1741
-------------- 139,280.00

PV of building & replacement cost = =N= 5,384,680.00
Annual equivalent over 60 yrs:
Interest at 6% ----------------------------- 0.06
ASF to replace =N=1 in 60 yrs @ 3% = 0.00613
x 0.06613
-------------- 356,088.89
Annual running costs = 150,000.00

COSTS – IN – USE OF SCHEME A **=N= 566,088.89**

Scheme B: **=N= : K**

Cost of site ---------------------------------- 1,000,000
Annual equivalent in perpetuity @ 6% = x 0.06
60,000.00

Cost of building -- 6,500,000.00
First replacement cost in 20 yrs = =N=400,000
PV of =N=1 in 20 yrs @ 6% = 0.3118
-------- 124,720.00

Second replacement cost in 40yrs = =N=400,000

PV of =N=1 in 40 yrs @ 6% = 0.0972

--------- 38,880.00

Replacement cost in 30 yrs = =N=500,000

PV of =N=1 in 30 yrs @ 6% = 0.1741

--------------- 87,050.00

PV of building and replacement costs = =N=6,750,650.00

Annual equivalent over 60yrs:

Interest @ 6% ---------------------------------- 0.06

ASF to replace =N=1 in 60 years @ 3% = 0.00613

------------ x 0.06613

---------------- 446,420.49

Annual running costs = 120,000.00

COSTS – IN –USE OF SCHEME B **=N=626,420.00**

DECISION

Scheme A is financially more favourable than Scheme B, as the considerably lower initial and replacement costs in A are not offset entirely by the reduced running costs in B, after discounting future costs.

CHAPTER TWENTY-FOUR

LIFE – CYCLE COSTING

24.1 Introduction

Life – cycle costing (LCC) can be defined as the costs associated with acquiring, using, caring for and disposing of physical assets, including feasibility studies, research and development, design, production, maintenance, replacement and disposal; as well as all the support, training operations costs generated by the acquisition, use, maintenance, and replacement of permanent physical assets. LCC could also be referred to as a technique that enables comparative cost assessments to be made over a specified period of time, taking in to account all relevant economic factors both in terms of initial capital costs and future operational costs.

Whole life – cycle costing (WLCC) is a methodology that involves the systematic analysis of the long – term cost implications of procurement decisions, whether for few new capital projects or in the development of asset maintenance strategies for existing buildings. WLCC studies take in to account not only the upfront capital costs of a project, but also the costs that will accrue throughout the life of the building, such as maintenance, energy and finance costs. In summary, WLCC is concerned with assessing the cost of an asset 'from cradle to grave'.

24.2 Comparison between LCC and WLCC

It is very important to distinguish Life – Cycle Costing (LCC) from Whole Life – Cycle Costing (WLCC) because many believe that WLCC is basically the same as the more well-known LCC; recent research suggests that this is not the case. The key difference between LCC and WLCC is the notion that WLCC is a management tool that is used throughout the building life, rather than the static option appraisal tool that LCC is generally used for.

The key message from all these is that best practice in cost planning now requires, where appropriate, a systematic consideration of the whole life costs of the asset (as given by WLCC), rather than simply the upfront capital costs (which LCC gives). It is therefore important to understand that the fundamental theory underlying WLCC is not new, nor are the mathematical constructs used to calculate costs, cash flow and other financial measures. Nevertheless, the key to successful application of WLCC lies in four areas as thus:

- ❖ Appropriateness of the methodology
- ❖ Quality of cost and performance data used
- ❖ Appropriate treatment of risk and uncertainty
- ❖ Involvement of the project stakeholders

24.3 Calculations of Whole – Life Cycle Costing

There is a variety of numerical approaches to the evaluation of WLCC, but the underlying theory is similar in most cases. In the most simplistic format, WLCC is given by the following formula:

$WLCC = C_C + O_C + R_C$ -- (24.1)

Where C_C = Capital Cost

O_C = Operational Cost

R_C = Residual Cost

The cost centres grouped into three categories in Equation 24.1 are illustrated in detail in Figure 24.1.

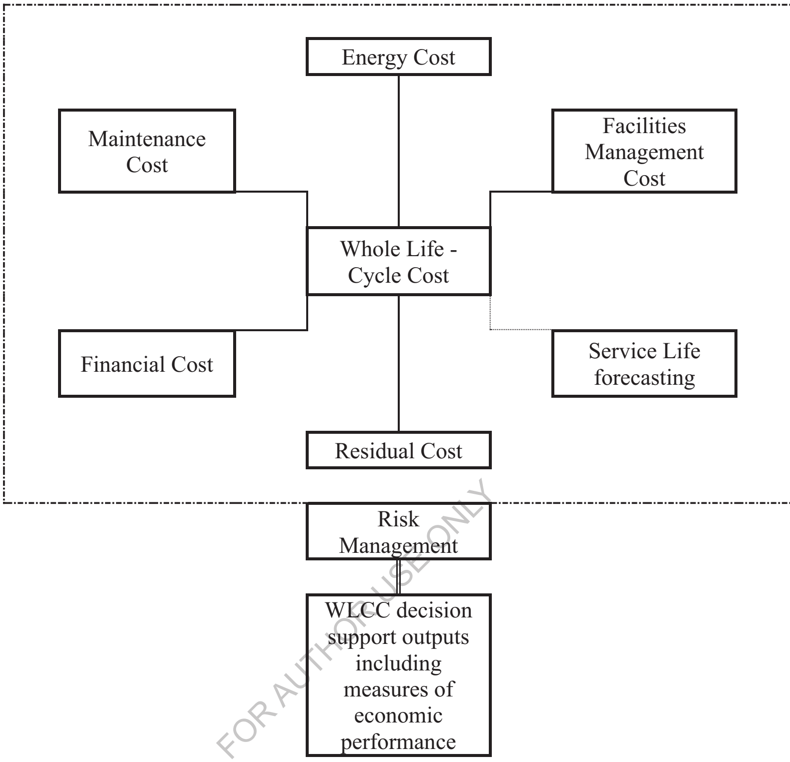


Fig. 24.1: Components of a Whole Life – Cycle Cost Analysis

To demonstrate a very basic WLCC model, the costs of two cladding systems are considered here.

Example 24.1
<u>Question</u>:
Compare the whole life costs of two types of cladding (A and B) to a factory building, whose life is intended to be 40 years. The rate of interest allowed is 3% per annum compound. Cladding A will cost =N=1,000,000.00, will require redecorating every 4 years at a cost of =N=120,000.00, and will require renewing after 20 years at a cost of =N=1,400,000.00. Cladding B will cost =N=1,800,000.00, and will last

the life of the building without maintenance of any kind, although a sum of =N-300,000.00 is to be allowed for general repairs after 20 years.

Solution:

Cladding A

		=N= : K
Capital cost		1,000,000.00
PV @ 3% of:		
Redecorating after 4yrs = =N=120,000 @ 0.8885	=	106,620.00
Redecorating after 8yrs = =N=120,000 @ 0.7894	=	94,728.00
Redecorating after 12yrs = =N=120,000 @ 0.7014	=	84,168.00
Redecorating after 16yrs = =N=120,000 @ 0.6232	=	74,784.00
Renewal after 20yrs = =N=1,400,000 @ 0.5537	=	775,180.00
Redecorating after 24yrs = =N=120,000 @ 0.4919	=	59,028.00
Redecorating after 28yrs = =N=120,000 @ 0.4371	=	52,452.00
Redecorating after 32yrs = =N=120,000 @ 0.3883	=	46,596.00
Redecorating after 36yrs = =N=120,000 @ 0.3554	=	42,648.00
		=N= 2,229,584.00

Cladding B

		=N= : K
Capital cost		1,800,000.00
PV @ 3% of:		
Repairs after 20 years = =N=300,000.00 @ 0.5537	=	166,110.00
		=N= 1,966,110.00

COMMENT:

Saving by using Cladding B is therefore;

=N=2,229,584.00 - =N=1,966,110.00 = **=N= 263,474.00**

It would therefore appear justifiable to use the initially expensive Cladding B, as this will prove much cheaper in the long run.

Note that the PV method of discounting has been used. This principle can be applied to as many components as required, although it can easily be appreciated how complex the model would be for an entire building.

The example above demonstrates the use of WLCC techniques at the sub-element level. Typically, however, owing to the magnitude that WLCC model is used, often based on the element level of BCIS Standard Form of Cost Analysis (SFCA) structure. WLCC is determined by the NPV (Net Present Value) method in this case (i.e., the sum of all PVs over the study period).

24.4 Challenges of Whole Life Costs Assessment

The benefits of WLCC have been shown in the definition or description of WLCC; indeed, the advantages of the technique for comparing costs are self-evident: it enables one to consider the long-term implications of a decision and to provide a way of showing the cost consequences of short-sighted economies.

Unfortunately, there are a number of fundamental challenges, which explain why this technique for comparing the cost of alternative materials and constructions has been seen more often in text books and in the University examination room than in real life. These challenges may be highlighted through three lines of argument as stated below:

- Initial and running costs cannot be equated
- The future cannot be forecast
- The process is heavily dependent on data and is overtly complex

CHAPTER TWENTY-FIVE

CONCEPT OF DISCOUNTING IN CASH FLOW MANAGEMENT

25.I Introduction

It is essential for cost planners to be aware of the importance of timing various payments and receipts in to a construction project. This is the foundation of sound project management and planning. The integrated process of planning these payments and receipts is conventionally referred to as cash flow management. Many construction companies become insolvent through bad estimating and planning, ineffective contract control or inadequate site cost control.

25.2 Definitions and Concept of Cash Flow Forecasting

Cash flow can be defined as the actual movement of money in and out of a business. Cash flow can also be referred to as the difference between income coming in to a project and the expenditure going out from the project. A project is in a position of negative cash flow when more money is going out of the project than coming in, and vice versa for positive cash flow. Within a construction organization positive cash flow is derived mainly from monies received through monthly payment certificates. Negative cash flow is related to monies expended on a contract to pay wages, purchase materials and plant, meet sub-contractor's accounts and overheads expended during the progress of construction. On a construction the net cash flow will require funding by the contractor when there is cash deficit; where cash is in surplus – the contract is self – financing.

Table 25.1 gives a basic example for one period. For "n" number of periods you would be able to produce an x – y line graph showing cash flow visually over the project duration.

Table 25.1: Cash Flow Statement for Period 1

Description	**Cash In (=N=)**	**Cash Out (=N=)**	**Net Cash Flow (=N=)**
Loan from finance institution	1,456,000		1,456,000
Sale of previous asset to finance project	312,500		1,768,500
Prime cost items		789,000	979,500

Design & Professional fees		80,000	899,500
Land charges		40,000	859,500

For large international contracting organizations, cash flow is not so much a problem (assuming normal economic conditions) since these companies are involved in many other ventures which provide for a relatively stable overall company balance sheet. However, for smaller contractors, cash flow can be critical and can be the difference between being in business or not. Poor cash flow is the antithesis of good business performance for most small contracting organizations, so accurate and effective cost planning is all the more critical.

25.3 Discounted Cash Flow Technique

Discounting is a method used to convert future costs or benefits to PVs using an applied discount rate, and is the cornerstone of the time value of money concept. Discounting is often confused with inflation but they are separate concepts. The discount rate is therefore not the inflation rate but it is the investment premium over and above the rate of inflation.

In Chapters 23 and 24, the concept of discounting as part of PV calculations was introduced. These techniques form the basis of what is commonly known in finance and economics as the discounted cash flow (DCF) technique. The Treasury defines DCF as ‘a technique for appraising investments’. It reflects the principle that the value to an investor (whether an individual or a firm) of a sum of money depends on when it is received. DCF methods determine the PV of future cash flows by discounting. This is necessary because cash flows in different time periods cannot be directly compared due to the time value of money notion. A typical discounted cash flow appraisal is shown in Tables 25.2 A and B.

In Table 25.2, Project A is seen to have an NPV of =N=2,457.00. This means that if we were to finance it at a rate of interest of 15%, the income that it generated would be insufficient to pay back all the borrowed money, interest on it at 15% and there would still be a sum of money whose PV is =N=2,457.00 left over at the end.

Table 25.2: Example of DCF Calculations for Two Investment Options (at 15%)

Project A

Year	Costs (=N=)	Net Income (=N=)	Net Cash Flow (=N=)	PV of 1 @ 15% (=N=)	DCF @ 15% (=N=)
0	-10,000		-10,000	1	-10,000
1	0	1,000	1,000	0.8696	870
2	0	2,000	2,000	0.7561	1,512
3	0	3,000	3,000	0.6575	1,973
4	0	3,500	3,500	0.7518	2,001
5	0	3,500	3,500	0.4972	1,740
6	0	4,000	4,000	0.4323	1,729
7	2,000	5,000	7,000	0.3759	2,632
NPV					**2,457**

Project B

Year	Costs (=N=)	Net Income (=N=)	Net Cash Flow (=N=)	PV of 1 @ 15% (=N=)	DCF @ 15% (=N=)
0	-12,000		-12,000	1	-12,000
1	0	2,500	2,500	0.8696	2,174
2	0	4,000	4,000	0.7561	3,025
3	0	4,000	4,000	0.6575	2,630
4	0	5,000	5,000	0.5718	2,859
5	0	3,000	3,000	0.4972	1,492
6	0	2,500	2,500	0.4323	1,081
7	3,000	2,000	5,000	0.3759	1,880
NPV					**3,141**

The decision rule for this kind of analysis is that the project with the highest NPV should be chosen provided that the rate of discount used is greater than the firm's cost of borrowing.

CHAPTER TWENTY-SIX

INVESTMENT APPRAISAL

26.1 Introduction

Most construction projects involve initial cash outlay in return for an anticipated flow of future benefits. Investment appraisal is an essential tool of project evaluation that leads to better decision. By its application, it is possible to question and justify the rationale about value for money and it becomes especially important where there is severe restraint on capital expenditure.

Though investment appraisal is so called because of its application to investment decisions, its principles apply to most decisions about how money or financial resources should be utilized efficiently such as in buildings, infrastructure, public buildings, private developments and equipment decisions.

26.2 Application and Uses of Investment Appraisal

It is sometimes argued that investment appraisal cannot or should not be used for public sector investments which do not produce commercial outputs. This opinion is held because of the concept of profit as the main recognizable measure of achievement. Apart from profit, satisfaction which seems to be the main objective of public investment goals can, to some extent, be rightly quantified and valued though not sold commercially. Appraisal where such value is utilized (i.e. where output cannot be valued commercially) is referred to as **'cost-benefit analyses'**. But in a situation where output cannot be valued commercially or otherwise, an appraisal can still be carried out to establish the cheapest way of providing a given output or satisfaction. This is called **'cost-effectiveness analyses'** or what different levels of output or levels of satisfaction would cost. Cost-benefit analysis is very widely used and it is therefore important that its methods be properly understood. The purpose of cost-benefit analysis is to provide a consistent procedure for evaluating decisions in terms of their consequences.

In a case where the market discipline of supply and demand is not at work, an appraisal of investments such as those undertaken by public organizations is the more important to ensure that public accountability and probity are upheld in financial transactions affecting development. It is better that the appraisal ends with a decision either to proceed or not with one of the expenditure options being appraised. Thereafter financial procedures are concerned with detailed planning and control, and the monitoring of expenditure as they are incurred against plans.

26.3 Steps of Carrying Out Investment Appraisal

An appraisal basically consists of the following steps:

(i) Definition of objectives
(ii) Identification of the costs and benefits
(iii) Discounting of costs and benefits
(iv) Weighing the uncertainties or sensitivity analysis
(v) Assessment of other factors and
(vi) Presentation of results.

The effort that should go in to an investment appraisal, and level of detail that should be considered, is usually a matter of judgement, but if the right questions are asked, the appropriate effort is often easy to contemplate. It may range from just a record that the expenditure is unavoidable to too low a profit margin. Whatever the situation there are no realistic alternatives to a detailed analysis demanding much time and effort.

26.4 Techniques for Investment Appraisal

Various techniques are in use in the appraisal of investment projects. The most commonly used ones are described with worked examples below.

24.6.1 Pay Back Method (PBM)

The pay back method considers the duration that initial outlay will be recouped, from the commencement of the function or utilization of the benefits of the investment. Consider two projects A and B with the following data:

Table 26.1: Investment Statements for Project A and B

Cash Flow Year	A (=N=)	B (=N=)
0	-100,000	-100,000
1	30,000	50,000
2	40,000	40,000
3	20,000	30,000
4	30,000	-
5	20,000	-

Solution:

Table 26.2: Computation of Cash Flows for Project A and B

	PROJECT A		PROJECT B	
Year	**Cash Flow (=N=)**	**Cumulative (=N=)**	**Cash Flow (=N=)**	**Cumulative (=N=)**
0	-100,000	-100,000	-100,000	-100,000
1	30,000	-70,000	50,000	-50,000
2	40,000	-30,000	40,000	-10,000
3	20,000	-10,000	30,000	20,000
4	30,000	20,000	-	-
5	20,000	40,000	-	-

PROJECT A
Payback period (PBP)
= 3 yrs + 10,000/30,00 x 12/1
= 3 yrs 4 months

PROJECT B
Payback period (PBP)
= 2 yrs + 10,000/30,00 x 12/1
= 2 yrs 4 months

The decision rule under the pay back method is that the shorter the period the more acceptable the project is to the investor. The shortcomings of this method are:

i. It adopts a short-sighted approach to investment
ii. It ignores the time value of money
iii. Future cash flows are ignored as soon as the payback period is reached
iv. It can only be used to supplement more advanced techniques

24.6.2 Return of Capital Employed (ROCE)

The ROCE evaluates project on the basis of the percentage of profit made on original investment. This is illustrated with projects A and B in Table 26.3.

Table 26.3: Investment Statements for Project A and B

Variable	**Project A (=N=)**	**Project B (=N=)**
Capital Outlay	30,000	30,000
Annual Profit	10,000	12,000

PROJECT A	**PROJECT B**
ROCE	ROCE
= =N=10,000/=N=30,000 x 100%	= =N=12,000/=N=30,000 x 100%
= 0.33 x 100%	= 0.4 x 100%
= 33.3%	= 40%

On the basis of the results, a basic project B is more acceptable.
The shortcomings of ROCE are:

- ✓ Time is not considered in this method
- ✓ Profit assessment is subjective depending on the cost methodologies.
- ✓ Time value of money is not considered as a single annual profit is used
- ✓ It can be used for appraising performance only and not the total investment

24.6.3 Discounted Cash Flow (DCF)

In the use of DCF four assumptions are made. These are:

- Absence of risk and uncertainty
- Absence of taxation
- Absence of inflation
- Absence of shortage of capital

The compounding value of money is derived from a Mathematical series such that P invested now at an interest of rate r and after n years will amount to S_n obtained as:

$$S_n = P(1+r)^n \text{ ------------------ } (26.1)$$

Similarly, the discounted value of S_n can also be computed as P which is the money that will be invested now to accumulate S_n in n years. From equation 26.1 above, we now have a formula to calculate P as thus:

$$P = [S_n/(1+r)^n] \quad = \quad S_n(1+r)^{-n}$$

The value of $(1+r)^{-n}$ is known as the discounted factor, by which the value S^n will be multiplied to obtain the discounted value. This technique can be illustrated given the following cash flow (Table 26.4).

Table 26.4: Cash Flow Statement for an Investment

Year	1	2	3	4
Cash Flow (=N=)	2,000	1,500	6,000	3,500

The expected discounted cash flow values at an interest rate of 10 per cent can be computed as shown in Table 26.5.

Table 26.5: Discounted Cash Flow Computation for an Investment

Year	**Cash Flow (=N=)**	**Discounting Factor**	**Discounted Value (=N=)**
1	2,000.00	0.9091	1,818.20
2	1,500.00	0.8264	1,239.60
3	6,000.00	0.7513	4,507.80
4	3,500.00	0.6831	2,390.85
TOTAL			**9,956.45**

Another example gives information on Projects A and B having the following projected cash flow at an interest rate of 12 per cent as shown in Table 26.6.

Table 26.6: Cash Flow Statement for 2 Projects

Year	**0**	**1**	**2**	**3**	**4**
Project A (=N=)	-100,000	30,000	40,000	20,000	80,000
Project B (=N=)	-100,000	50,000	40,000	50,000	-

With the use of the PV Tables in the Appendix, the values of the discounting factors at interest rate of 12 percent can be obtained from the present worth factor column as shown in Tables 26.7 and 26.8.

Table 26.7: Discounted Cash Flow Computation for Project A

Year	**Cash Flow (=N=)**	**Discounting Factor**	**Discounted Value (=N=)**
0	-100,000	1.0000	-100,000.00
1	30,000	0.8929	26,787.00
2	40,000	0.7972	31,888.00
3	20,000	0.7118	14,236.00
4	80,000	0.6355	50,840.00
Total			**=N= 23,751.00**

Table 26.8: Discounted Cash Flow Computation for Project B

Year	Cash Flow (=N=)	Discounting Factor	Discounted Value (=N=)
0	-100,000	1.0000	-100,000.00
1	50,000	0.8929	44,645.00
2	40,000	0.7972	31,888.00
3	50,000	0.7118	35,590.00
Total			**=N= 12,123.00**

The decision rules of the NPV method are:

- ❖ Accept investment with positive NPV.
- ❖ The greater the NPV, the more acceptable the project.

24.6.4 Internal Rate of Return (IRR)

The internal rate of return can be defined as that rate which equates the present value of cash inflows with the present value of cash outflows of an investment. In other words, it is the rate at which the net present value of the investment is zero. It is called internal rate because it depends solely on the outlay and proceeds associated with the investment. Therefore, the discounting rate that makes the value of the NPV to be equal to zero is referred to as the **internal rate of return**. The application of the IRR method is illustrated by a typical example below:

Table 26.9: Cash Flow Statement for Project A

Year	0	1	2	3	4	5
Cash Flow (=N=)	-100,000	30,000	40,000	20,000	30,000	20,000

To compute the IRR value, two rates are chosen so as to include the critical value when the NPV is zero. In the case of 'Project A', the two rates deemed reliable and chosen are 12% and 18%. Therefore, given the cash flow projection in Table 26.9, the IRR can be computed as shown in Table 26.10.

Table 26.10: Discounted Cash Flow (NPV) Computed for Project A

Year	**Cash Flow (=N=)**	**DCF @ 12%**	**NPV (=N=)**	**DCF @ 18%**	**NPV (=N=)**
0	-100,000	1.0000	-100,000	1.0000	-100,000
1	30,000	0.0929	26,787	0.8474	25,422
2	40,000	0.7972	31,888	0.7181	28,724
3	20,000	0.7118	14,236	0.6086	12,172
4	30,000	0.6355	19,065	0.5158	15,474
5	20,000	0.5674	11,348	0.4371	8,742
			=N=3,324		**- =N=9,466**

From Table 26.10, IRR can be determined for Project A by graphical means as thus:

SCALE: 10 Units = 1% on × - Axis; 1 Unit = =N=200 on the y - Axis

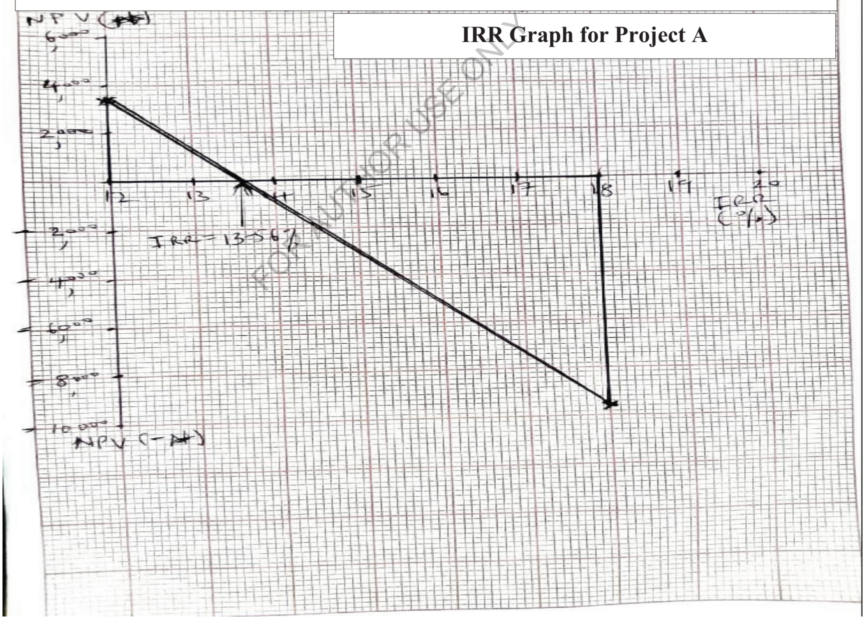


Fig. 26.1: IRR Graph for Project A

On the other hand, IRR can be determined for Project A by Mathematical computation by using the formula expressed as Equation 26.2 and data from Table 26.10 as thus:

IRR = [(∑NPVs for Lower Rate x Higher – Lower Rates)] -------------------- (26.2)
(Higher + Lower Rate)

N.B: The signs (+ or -) assumed by the computed NPVs (i.e., for the lower and higher rates) should be ignored when using Equation 26.2.

IRR = 12% + [(=N=3,324 x 6.00) / =N= (9,466 + 3,324)]

= (12 + 1.56) = 13.56%

Table 26.11: Cash Flow Statement for Project B

Year	0	1	2	3
Cash Flow (=N=)	-100,000	50,000	40,000	30,000

Recall that in order to compute the IRR value, two rates are chosen so as to include the critical value when the NPV is zero. In the case of 'Project B', the two rates deemed reliable and chosen are 9% and 12%. Therefore, given cash flow projection in Table 26.11, the IRR can be computed as shown below in Table 26.12:

Table 26.12: Discounted Cash Flow (NPV) Computed for Project B

Year	**Cash Flow (=N=)**	**DCF @ 9%**	**NPV (=N=)**	**DCF @ 12%**	**NPV (=N=)**
0	-100,000	-	-100,000	-	-100,000
1	50,000	0.9174	45,870	0.8929	44,645
2	40,000	0.8417	33,668	0.7972	31,888
3	30,000	0.7722	23,166	0.7118	21,354
			=N=2,704		**-=N=2,113**

From Table 26.12 IRR can be determined for Project B, by graphical means as thus:

SCALE: 2 Units = 1% on x - Axis; 1 Unit = =N=100 on the y - Axis

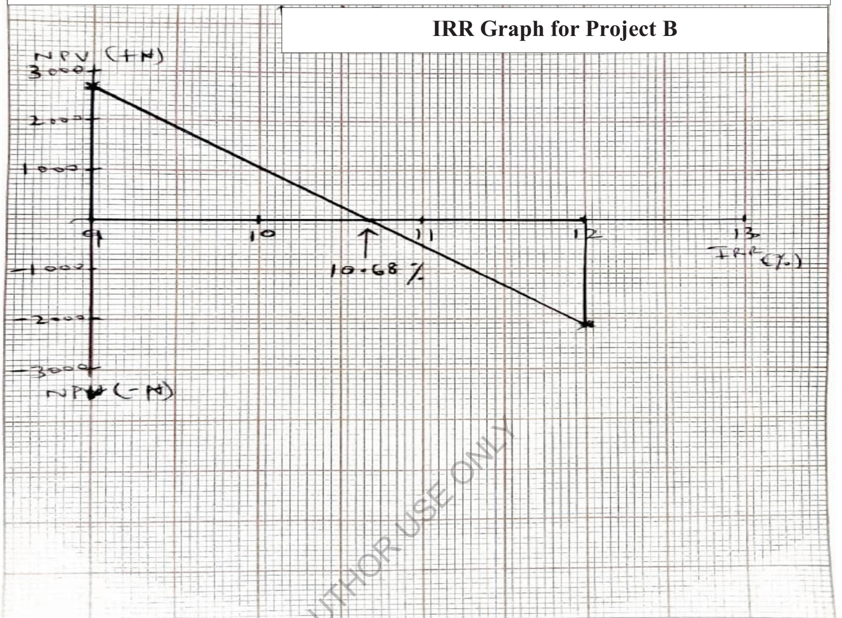


Fig. 26.2: IRR Graph for Project B

Similarly, on the other hand, IRR can be determined for Project B by Mathematical computation, from Table 26.12 and using Equation 26.2 as thus:

IRR = 9% + [(=N=2,704 x 3.00) / =N= (2,704 + 2,113)]

= (9% + 1.68) = 10.68%

The decision rules for the adoption of IRR in the above example are:

- An investment A is acceptable if the value of IRR is greater than the interest on capital.
- The method is usually employed to classify various projects for detailed investigation in the order of economic profitability.

Since the IRR value of the project A is greater than project B, and then it will be more profitable to choose Project A for detailed consideration.

CHAPTER TWENTY-SEVEN

PRICE FLUCTUATIONS AND PROCEDURES FOR PREPARING FINAL ACCOUNT

27.1 The Concept of Fluctuation in the Construction Industry

Fluctuation can be defined as increase or decrease (change) in wages and emoluments, prices of materials and taxes from the base date through to project completion. Changes in wage rates and prices of materials over the years have made it difficult to predict the final cost of a project at the time of tender. Sometimes, firm price contracts were the norm and contractors were expected to bear the loss if price increases occurred and enjoy the benefits if price decreases occurred. Consequently, contractors at the time of tender tried to anticipate the price increases that would likely occur and bill accordingly. This means that if prices did not increase to the levels anticipated, the contractor makes more profits, and if, on the other hand, prices increased beyond the anticipated levels, then the contractor is tempted to do shoddy work so as to reduce his/her losses. Whichever way, the client is short changed. Nowadays, most contract forms include a fluctuation clause which deals specifically with any increase, or decrease in wage rates and prices of materials during a contract period. The conditions of contract will usually specify the extent of fluctuation to be considered.

The main reason for including fluctuation provision in a contract is the fear of inflation. It may, therefore, be considered more beneficial to include fluctuation provisions so that price increase or decrease does not affect the successful completion of the project. In addition, if there are some uncertainties as to the time a project will commence, it may be wise to allow for fluctuation. This protects both the client and the contractor if there is a time lapse between date of tender and time when contract commences.

27.2 Types of Fluctuations

There are basically three forms of fluctuations to be considered in a contract. These are Firm Price Contracts, Limited Fluctuations and Full Fluctuations.

27.2.1 Firm Price Contracts

In Firm Price Contracts, fluctuations are not allowed for during the contract. Contractors are expected to bear the loss if prices increase occurs and enjoy the benefits if price decreases occur. This is the case with Federal Government contracts in Nigeria whose completion period does not exceed 12 months.

27.2.2 Limited Fluctuations

In the Limited Fluctuations category, fluctuations are allowed only on certain specified items. These are usually considered principal items. This is the case with Federal Government contracts in Nigeria whose completion period exceeds 12 months.

27.2.3 Full Fluctuations

Under the Full Fluctuations category, fluctuation is allowed on all items of materials and labour.

27.3 Procedure for Valuing Fluctuations

Fluctuations are usually allowed for in interim valuations although no directions to that effect are specified in the conditions of contract. The assessment of the value of fluctuation is progressive and the cumulative total is added to each valuation. There are two methods of calculating fluctuations in the contract conditions; assessment by analysis and presentation of statement of material fluctuations.

27.3.1 Assessment by Analysis

This is the traditional method in which the value of fluctuation is not subject to retention. The most commonly used form of contract in Nigeria is Federal Ministry of Works, "Lump Sum Contract" and includes a Clause 31, which covers 'Fluctuations'. This clause reads in part: "The Contract Sum shall be deemed to have been calculated in the manner set out below and shall be subject to fluctuations;

1. The prices contained in the Contract Bills are based upon the rates of wages and other emoluments and expenses (including the cost of Employer's Liability Insurance and Third-Party Insurance) payable by the Contractor to work people engaged upon or in connection with the Works in accordance with the rates of wages fixed by the Federation of Building and Civil

Engineering Contractors (FORBACEC), current at the date of tender and applicable to the area concerned.

2. If the said rates of wages and other emoluments and expenses (including the cost of Employer's Liability Insurance and Third-Party Insurance) shall be increased or decreased after the said date of signing of the Contract, the net increase or decrease of such wages and other emoluments and expenses shall be in addition to or a deduction from the Contract Sum as the case may be.
3. The prices contained in the Contract Bills are based upon the market price of the materials and goods specified in the list attached thereto which were current at the date of tender. Such prices are hereinafter referred to as 'basic prices'.
4. If after the date of tender the market prices of any of the materials or goods specified as aforesaid increases or decreases, then the net amount of the difference between the basic price thereof and the market price payable by the Contractor and the current price when the materials or goods are bought shall, as the case may be, be paid to or allowed by the Contractor."

The Contractor is expected to give written notice to the Architect/Supervising Officer of any fluctuation in prices and he is expected to do so as quickly as possible so that all claims are settled by the next monthly valuation. Additions or deductions made to the Contract Sum as a result of the fluctuation clause are not to alter in any way the amount of profit of the Contractor included in the Contract Sum. The practical implications of this are as follows:

1. Labour

Basic wage rates are those fixed by FORBACEC current at the date of tender and applicable to that area. The 'date of tender' is taken to be 10 days before the date that tenders are expected to be returned to the client. Payments for insurance on the workers are also subject to fluctuation since these are usually determined as a percentage of the basic wage. According to Clause 31 under JCT Form of Contract, Contractors are expected to submit claims for fluctuations at regular intervals with supporting time sheets. The Clerk of Works is expected to sign the time sheets to certify that the work listed are actually worked on the site for the number of hours stated.

2. **Materials**

A basic price list of materials is attached to the bill of quantities. Sometimes, a blank price list is incorporated in the Bill of Quantities and a tenderer is instructed to enter the materials and their market prices for which he/she may require adjustment. Alternatively, as with most government agencies, a standard list of items is included. Any material not listed here is not subject to fluctuation. For uniformity among tenderers, some agencies send out basic price lists with tender documents, which have materials and prices, entered. Vouchers and invoices must accompany any claims for adjustment and only net fluctuations will be taken into account. As with wage rate fluctuations, written notice of all price fluctuations must be given to the Architect as they arise.

27.3.2 Preparation of Statement of Materials Fluctuation

The contractor usually prepares this and submits to the Quantity Surveyor for checking along with all the supporting invoices. All the materials listed on the basic price lists must be adjusted for and all invoices for every material appearing on the list must be submitted. Even when the invoice price is the same as basic price and fluctuation shows in the statement as nil, they must be submitted to show that the material has not been overlooked. This is also useful for checking total amounts of materials claimed for on a particular project to ensure that the contractor is not claiming for materials bought and used on other contracts.

27.4 Introduction to the Concept of Final Account in Construction

In an "entire contract", one party is expected to carry out all his/her part of the contract before he/she can ask the other to carry out his/her own part. Technically, this means that in a construction contract, once the contractor has agreed to carry out a construction project for a contract sum as it is without adjustment. However, the nature of construction both for its size and complexity that warrants such a contractual requirement would place a huge financial burden upon the contractor's cash flow and working capital. The implication of this would be that the resultant interest would be charged to projects, thereby increasing tender prices across the industry. If contracts were to be paid in one installment upon completion, the chances are that many contractors would buckle under the financial stress thereby increasing the already high insolvency problem in the construction industry.

In order to forestall the potential problems, most standard forms make provision for interim or stage payments withing contracts. Modern construction involves a heavy financial outlay and spans over a considerable time frame. Contractors that have the capacity for such a financial burden with its attendant risks are very few. Even if contractors could wholly finance projects in this manner, the high interest rates would be reflected in the contract sum, which may now become a problem for the client. In view of these, both contractor and the client benefit from an arrangement where the client makes payments in installments to the contractor for work in progress. These payments in installments are based on interim valuations prepared by the Quantity Surveyor.

Generally, construction is very complex and it is common to find it necessary to alter the initial design, quality or quantity of work during actual construction. Most contract forms therefore provide a system for evaluating the cost of changes in design, quality or quantity of the work during the progress of the contract. These changes are known as variations and are measured, valued and added to or deducted from the contract sum as the case may be.

The time lag from start to finish of construction projects also means that prices on which the contract sum was based are likely to change before the construction is completed. Most contract forms allow for the effect of changes in price levels of all inputs into the project. These changes in price levels are valued as fluctuation and are added to or deducted from the contract sum as the case may be. In effect, the contract sum agreed on at the beginning of a project is hardly the amount eventually paid to the contractor at the end of the project. It is the duty of the Quantity Surveyor to keep track of all the decisions made during the project that affect the contract sum and also to periodically advice on amounts due to the contractor for installment payments.

Financial statements and financial reports are also required periodically so as to keep track of expenditure, and give the client a good picture of the financial status of the contract and an estimate of how much more will be required to complete the project. The final settlement of accounts at the end of the project is also the responsibility of the Quantity Surveyor.

27.5 Valuations

Valuation may be defined as a formal assessment of worth of work executed. Valuations are carried out during construction to determine the amounts due 'on account' to the contractor as interim payments and at the completion of the project a final account is prepared to reconcile accounts. In the construction industry, a valuation is a periodic assessment of the total value of work properly executed to date. This total value should include all or some of the following:

1. Value of work executed according to contract (that is as shown on the contract drawings and described or referred to in the contract bills).
2. Value of any variations or changes of work.
3. Value of materials and goods supplied by nominated suppliers.
4. Value of work executed by nominated sub-contractors.
5. Value of materials for use in the works delivered to site or adjacent to the works (that is materials on site).

Table 27.1 shows a sample of a typical valuation assessment sheet.

Table 27.1: Sample of Valuation Assessment Sheet

Item Description	Omission	Addition
1. Estimated total value of work executed as contract		
a. Preliminaries		
b. Substructure		
c. Superstructure		
2. Valuation (Omit/Add)		
3. Nominated subcontractors' work to date		
4. Nominated suppliers work to date		
5. Materials on site		
6. Deduct retention (5%)		
7. Fluctuation (Add/Omit)		
8. Deduct previous payments		

Source: Ikupolati and Olaleye (2016)

27.6 Final Account

In the construction industry, the final account is the concluding statement of the financial transactions, which took place between the client and the contractor during construction of a project. Its preparation involves the reconciliation of the financial implications of all decisions made in the fulfilment of contractual obligations as stipulated by the conditions of contract. The main purpose of the final account is to determine the amount due to the contractor in his final payment. The final account figure also gives the client exact cost to him/her of the construction project. The Final Account Figure, sometimes referred to as the Final Account Sum, is the adjusted contract sum or Contract Sum – Omissions + Additions. The original contract sum is adjusted to take care of Variations, Provisional Quantities, Prime Cost Sums, Provisional Sums, Claims for Loss and Expenses and Fluctuations. From this adjusted contract sum is deducted all previous payments to the contractor. The balance represents the final payment to the contractor. Table 27.2 shows the sample of a typical final account statement sheet.

Table 27.2: Sample of Final Account Statement Sheet

Item Description	**Omission**	**Addition**
Contract sum		
Contingencies		
Provisional quantities		
Variations		
Prime cost sums		
Less omissions		
Final account sum		
Less previous payment		
Valuation 1 – the last		
Full retention		
Balance due to the contractor		

Source: Ikupolati and Olaleye (2016)

27.7 Variation Account

Clause 11 of the Federal Ministry of Works Standard Form of Contract defines variation as the alteration or modification of the design, quantity or quality of the works as shown on the contract drawings and described or referred to in the contract bills and includes the addition, omission or substitution of any work, the alteration of the kind or standard of any material or goods to be used in the works and the removal from site of any work or materials or goods executed or brought there by the contractor for the purposes of the works. A variation may be either of the following types:

1. A substitution: For example, Omit Polyvinyl chloride (PVV) tiles in entrance lobby and substitute with in-situ terrazzo paving.
2. An omission: For example, Omit all Masonia pelmets.
3. An addition: For example. Apply Dieldrex anti-termite treatment to all faces of excavation.

27.7.1 Ordering of Variations

Variations must be based on Architect's Instructions. Architect's Instructions must be given in writing. When instructions are given verbally, they must be confirmed in writing within a specified period. Architect's Instructions may arise as follows:

1. The Contractor should confirm Architect's verbal instruction in writing within seven (7) days. The Architect has the opportunity during those seven days to dissent; otherwise, the instruction takes immediate effect. The Architect then has to confirm in writing at any later time, before the issue of the final certificate.
2. If the Contractor carries out any variation deemed necessary without authorization, the Architect can subsequently sanction in writing.
3. Any directives given by the Clerk of Works only becomes effective if confirmed by the Architect within two (2) days.

The second part of Clause 11.1 states: "No variation required by the Architect/Supervising Officer or subsequently sanctioned by him shall vitiate the Contract" (JCT, 2009). This simply implies that the Architect may not issue a variation, which is so extensive that it totally changes a contract. For instance, in a contract to construct a 4 – storey office block, an ancillary building and a garage, a variation order cannot be issued to omit the office block. Excessive variations would have to form the basis of a new contract.

The important thing for the Quantity Surveyor is that the Architect has to sanction in writing a variation before he/she can value it. In presenting the variation account, the Quantity Surveyor should make reference to the relevant written order for each variation valued. It is not all Architect's Instructions that constitute variations, but where they do, the Quantity Surveyor is expected to measure and value the variations while giving opportunity to the contractor or his/her representative to be present at such measurement and to take notes.

Architect's and Contract Administrator's Instructions that constitute variations are usually written in triplicate: one copy is sent to the contractor; one copy goes to the Quantity Surveyor and one copy is retained by the Architect or contractor's administrator. Each architect's Instruction constituting a variation must give the following information:

1. Title of contract
2. Name of contractor
3. Date and serial number of Architect's Instruction
4. Full details of the variation accompanied by appropriate drawings where necessary
5. Architect's signature

Where the Architect's Instruction involves the adjustment of Prime Cost Sums, particulars must be given of the estimate to be accepted stating the date of the quotation and the reference number. The Architect and Quantity Surveyor's copies of the variation order may include the approximate cost of the variation and if required, a summary of the balance remaining in the contingency sum. The Architect is usually allowed to use his/her discretion in instructing variations where thay are:

1. Unavoidable and essential for the contract to proceed.
2. Of a minor, routine nature with minor cost implications.
3. Urgently required.

The client's prior approval is however required where the variation is significant in terms of design or cost.

27.7.2 Measurement of Variations

Variation should be measured and valued as quickly as possible for the following reasons:

1. The variation account can be completed within a reasonable time after completion of the work.
2. The financial effect of the larger and more important variations can be settled in time so that their value can be included in interim certificates and in financial statements to the client that are issued from time to time.

Each variation is measured carefully and proper records are kept as each occurs. This makes the preparation of the variation account during the final accounting a simple process. The Federal Ministry of Works Form of Contract clearly states that the responsibility for the preparation and evaluation of variations is with the consultant Quantity Surveyor. However, many practices allow the contractor's Quantity Surveyor to prepare and value the variation and then submit for approval. The JCT (2005) has formalized this procedure by making it an option for the valuing of variations. The rules of measuring and valuing variations however remain the same no matter who is doing the work.

Revised drawings incorporating variations when received by the Quantity Surveyor should be stamped with a large red "V" or "post-contract", a predetermined position to distinguish them from the original drawings. It is also necessary to mark the drawings with the date of receipt. If the variation drawings supersede some contract drawings, these should be marked and identified as such in order to reduce the risk of using outdated information in the preparation of the final account.

It is helpful to maintain a separate file for Architect's Instructions with other correspondence relating to variations. This will be helpful in clarifying the designer's intent and thereby making measurement easier. Arrangements must be made with the contractor's representative on site and the clerk of works to keep accurate records of work that will subsequently be covered up. For example, depth of foundations, steps in foundations and thickness of hardcore.

If accurate drawings, drawn to scale, are issued as part of the variations, then the variation is measured from these drawings. If, however, only sketches are issued by the Architect, then site measurement has to be undertaken for the variation in question. Some situations may require a combination of both procedures, for example, additional foundations and drainage work where dimensions of trench or pit excavation shown on drawings may vary from the actual quantities of work carried out on the site. Site measurement may be taken and entered in a "dimension book" and the dimensions worked up later in the office. Alternatively, a schedule of items to be measures can be prepared in the office and taken to site and used as a checklist or drawings are made in the office which can now be dimensioned and annotated on site using actual measurements and observations.

Omissions are usually extracted from the Quantity Surveyor's original dimensions on the taking-off sheets except in cases where the whole items or sections of the bill are omitted, in which case reference can be made to the appropriate bill items. The Quantity Surveyor should be prepared to make the original dimensions available for inspection by the contractor's representative. The Quantity Surveyor must also give the contractor opportunity to be present or be represented when site visits are made for the purpose of measuring variations.

It is important keep omissions and additions separate and distinct and by convention, the words 'omit' and 'add' should be written as a heading for each set of dimensions relating to an omission or addition as the case may be. Some practices use different colours of ink to measure additions and omissions. Each item of variation should be headed with the reference number of the Architect's Instruction, the date issued, the date carried out and a brief description of the content of the instruction.

27.7.3 Valuation of Variations

Pricing of variation items are governed by the following rules:

1. Where identical work is already priced in the bill, the bill rates is used.
2. Where work is not identical but similar, the bill rate is used as a basis for calculating a new price.
3. Where it is not practicable to apply a bill rate directly or as a basis, a fair valuation must be made and agreed by both parties.
4. Where work cannot be properly measured and valued, the contractor is allowed a prime cost of resources employed (Daywork) with percentage additions to each section of the prime cost. These percentage additions and rates would already have been set out by the contractor in the appendix to the contract.
5. All omissions from the contract are valued at the rates contained in the contract bills unless the omission of such work is so extensive that it varies the contract conditions under which the remaining work is to be carried out, then the remaining work is re-valued using the original bill rates as basis.
6. Where the Architect thinks that a variation has involved the contractor in direct loss or expense for which he/she will not be recompensed under any of the above considerations, then the Architect or Quantity Surveyor is to ascertain the amount which is to be added to the contract sum. For example,

work that will involve re-erection of scaffolding after it has been dismantled and removed from site.

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APPENDICES

Table A1: Present Value of =N-1 Per Annum or Year's Purchase Table

Years	2	2½	3	3½	4	4½	Rate per cent 5
1	0.9803	0.9756	0.9708	0.9661	0.9615	0.9569	0.9523
2	1.9415	1.9274	1.9134	1.8996	1.8860	1.8726	1.8594
3	2.8838	2.8560	2.8286	2.8016	2.7750	2.7489	2.7232
4	3.8077	3.7619	3.7170	3.6730	3.6296	3.5875	3.5459
5	4.7134	4.6458	4.5797	4.5150	4.4518	4.3899	4.3294
6	5.6014	5.5081	5.4171	5.3285	5.2421	5.1578	5.0756
7	6.4719	6.3493	6.2302	6.1145	6.0020	5.8927	5.7863
8	7.3254	7.1701	7.0196	6.8739	6.7827	6.5958	6.4632
9	8.1622	7.9708	7.7861	7.6076	7.4353	7.2687	7.1078
10	8.9825	8.7520	8.5302	8.3166	8.1108	7.9127	7.7217
11	9.7868	9.5142	9.2326	9.0015	8.7604	8.5289	8.3064
12	10,5753	10.2577	9.9540	9.6633	9.3850	9.1185	8.8632
13	11.3483	10.9831	10.6349	10.3027	9.9856	9.6828	9.3935
14	12.1062	11,6909	11.2960	10.9205	10.5631	10.2228	9.8996
15	12.8492	12.3813	11.9379	11.5174	11.1183	10.7395	10.3796
16	13.5777	13.0550	12.5611	12.0941	11.6522	11.2340	10.8377
17	14.2918	13.7121	13.1661	12.6513	12.1656	11.7071	11.2740
18	15.9920	14.3533	13.7535	13.1896	12.6592	12.1599	11.6895
19	15.6784	14.9788	14.3237	13.7098	13.1339	12.5932	12.0853
20	16.3514	15.5891	14.8774	14.2124	13.5903	13.0079	12.4622
21	17.0112	16.1845	15.4150	14.6979	14.0291	13.4047	12.8211
22	17.6580	16.7654	15.9369	15.1671	14.4511	13.7844	13.1630
23	18.2922	17.3321	16.4436	15.6204	14.8568	14.1477	13.4885
24	18.9139	17.8849	16.9355	16.0583	15.2469	14.4954	13.7986
25	19.5234	18.4243	17.4131	16.4815	15.6220	14.8282	14.0939
26	20.1210	18.9506	17.8768	16.8903	15.9827	15.1466	14.3751
27	20.7068	19.4640	18.3270	17.2853	16.3295	15.4513	14.6430
28	21.2812	19.9648	18.7641	17.6670	16.6630	15.7428	14.8981
29	21.8443	20.4535	19.1884	18.0357	16.9837	16.0218	15.1410
30	22.3964	20.9302	19.6004	18.3920	17.2920	16.2888	15.3724
35	24.9986	23.1451	21.4872	20.0006	18.6646	17.4610	16.3741
40	27.3554	25.1027	23.1147	21.3550	19.7927	18.4015	17.1590
45	29.4901	26.8330	24.5187	22.4954	20.7200	19.1563	17.7740
50	31.4236	28.3623	25.7297	23.4556	21.4821	19.7620	18.2559
55	33.1747	29.7139	26.7744	24.2640	22.1086	20.2480	18.6334
60	34.7608	30.9086	27.6755	24.9447	22.6234	20.6380	18.9292
65	36.1974	31.9645	28.4528	25.5178	23.0466	20.9509	19.1610
70	37.4986	32.8978	29.1234	26.0003	23.3945	21.2021	19.3426
75	38.6771	33.7227	29.7018	26.4066	23.6804	21.4036	19.4849
80	39.7445	34.4518	30.2007	26.7487	23.9153	21.5653	19.5964
85	40.7112	35.0962	30.6311	27.0368	24.1085	21.6951	19.6838
90	41.5869	35.6657	31.0024	27.2793	24.2672	21.7992	19.7522
95	42.3800	36.1691	31.3226	27.4835	24.3977	21.8827	19.8058
100	43.0983	36.6141	31.5989	27.6554	24.5049	21.9498	19.8479

compound interest

5½	6	6½	7	7½	8	9	10
1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
0.48661	0.48543	0.48426	0.48309	0.48192	0.48076	0.47846	0.47619
0.31565	0.31410	0.31257	0.31105	0.30953	0.30803	0.30505	0.30211
0.23029	0.22859	0.22690	0.22522	0.22356	0.22192	0.21866	0.21547
0.17917	0.17739	0.17563	0.17389	0.17216	0.17045	0.16709	0.16379
0.14517	0.14336	0.14156	0.13979	0.13804	0.13631	0.13291	0.12960
0.12096	0.11913	0.11733	0.11555	0.11380	0.11207	0.10869	0.10540
0.10286	0.10103	0.09923	0.09746	0.09572	0.09401	0.09067	0.08744
0.08883	0.08702	0.08523	0.08348	0.08176	0.08007	0.07679	0.07364
0.07766	0.07586	0.07410	0.07237	0.07068	0.06902	0.06582	0.06274
0.06857	0.06679	0.06505	0.06335	0.06169	0.06007	0.05694	0.05396
0.06102	0.05927	0.05756	0.05590	0.05427	0.05269	0.04965	0.04676
0.05468	0.05296	0.05128	0.04965	0.04806	0.04652	0.04356	0.04077
0.04927	0.04758	0.04594	0.04434	0.04279	0.04129	0.03843	0.03574
0.04462	0.04296	0.04135	0.03979	0.03828	0.03682	0.03405	0.03147
0.04058	0.03895	0.03737	0.03585	0.03439	0.03297	0.03029	0.02781
0.03704	0.03544	0.03390	0.03242	0.03100	0.02962	0.02704	0.02466
0.03391	0.03235	0.03085	0.02941	0.02802	0.02670	0.02421	0.02193
0.03115	0.02962	0.02815	0.02675	0.02541	0.02412	0.02173	0.01954
0.02867	0.02718	0.02575	0.02439	0.02309	0.02185	0.01954	0.01745
0.02646	0.02500	0.02361	0.02228	0.02102	0.01983	0.01761	0.01562
0.02447	0.02304	0.02169	0.02040	0.01918	0.01803	0.01590	0.01400
0.02266	0.02127	0.01996	0.01871	0.01753	0.01642	0.01438	0.01257
0.02103	0.01967	0.01839	0.01718	0.01605	0.01497	0.01302	0.01129
0.01954	0.01822	0.01698	0.01581	0.01471	0.01367	0.01180	0.01016
0.01819	0.01690	0.01569	0.01456	0.01349	0.01250	0.01071	0.00915
0.01695	0.01569	0.01452	0.01342	0.01240	0.01144	0.00973	0.00825
0.01581	0.01459	0.01345	0.01239	0.01140	0.01048	0.00885	0.00745
0.01476	0.01357	0.01247	0.01144	0.01049	0.00961	0.00805	0.00672
0.01380	0.01264	0.01157	0.01058	0.00967	0.00882	0.00733	0.00607
0.00997	0.00897	0.00806	0.00723	0.00648	0.00580	0.00463	0.00368
0.00732	0.00646	0.00569	0.00500	0.00440	0.00386	0.00295	0.00225
0.00543	0.00470	0.00405	0.00349	0.00301	0.00258	0.00190	0.00139
0.00406	0.00344	0.00291	0.00245	0.00207	0.00174	0.00122	0.00085
0.00305	0.00253	0.00210	0.00173	0.00143	0.00117	0.00079	0.00053
0.00230	0.00187	0.00152	0.00122	0.00099	0.00079	0.00051	0.00032
0.00174	0.00139	0.00110	0.00087	0.00068	0.00054	0.00033	0.00020
0.00132	0.00103	0.00080	0.00061	0.00047	0.00036	0.00021	0.00012
0.00101	0.00076	0.00058	0.00044	0.00033	0.00024	0.00014	0.00007
0.00076	0.00057	0.00042	0.00031	0.00023	0.00016	0.00009	0.00004
0.00058	0.00042	0.00030	0.00022	0.00016	0.00011	0.00005	0.00003
0.00044	0.00031	0.00022	0.00015	0.00011	0.00007	0.00003	0.00001
0.00034	0.00023	0.00016	0.00011	0.00007	0.00005	0.00002	0.00001
0.00026	0.00017	0.00011	0.00008	0.00005	0.00003	0.00001	0.00000

Source: Ikupolati and Olaleye (2016)

Table A2: Annual Sinking Fund Table

compound interest

5½	6	6½	7	7½	8	9	10
1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
0.48661	0.48543	0.48426	0.48309	0.48192	0.48076	0.47846	0.47619
0.31565	0.31410	0.31257	0.31105	0.30953	0.30803	0.30505	0.30211
0.23029	0.22859	0.22690	0.22522	0.22356	0.22192	0.21866	0.21547
0.17917	0.17739	0.17563	0.17389	0.17216	0.17045	0.16709	0.16379
0.14517	0.14336	0.14156	0.13979	0.13804	0.13631	0.13291	0.12960
0.12096	0.11913	0.11733	0.11555	0.11380	0.11207	0.10869	0.10540
0.10286	0.10103	0.09923	0.09746	0.09572	0.09401	0.09067	0.08744
0.08883	0.08702	0.08523	0.08348	0.08176	0.08007	0.07679	0.07364
0.07766	0.07586	0.07410	0.07237	0.07068	0.06902	0.06582	0.06274
0.06857	0.06679	0.06505	0.06335	0.06169	0.06007	0.05694	0.05396
0.06102	0.05927	0.05756	0.05590	0.05427	0.05269	0.04965	0.04676
0.05468	0.05296	0.05128	0.04965	0.04806	0.04652	0.04356	0.04077
0.04927	0.04758	0.04594	0.04434	0.04279	0.04129	0.03843	0.03574
0.04462	0.04296	0.04135	0.03979	0.03828	0.03682	0.03405	0.03147
0.04058	0.03895	0.03737	0.03585	0.03439	0.03297	0.03029	0.02781
0.03704	0.03544	0.03390	0.03242	0.03100	0.02962	0.02704	0.02466
0.03391	0.03235	0.03085	0.02941	0.02802	0.02670	0.02421	0.02193
0.03115	0.02962	0.02815	0.02675	0.02541	0.02412	0.02173	0.01954
0.02867	0.02718	0.02575	0.02439	0.02309	0.02185	0.01954	0.01745
0.02646	0.02500	0.02361	0.02228	0.02102	0.01983	0.01761	0.01562
0.02447	0.02304	0.02169	0.02040	0.01918	0.01803	0.01590	0.01400
0.02266	0.02127	0.01996	0.01871	0.01753	0.01642	0.01438	0.01257
0.02103	0.01967	0.01839	0.01718	0.01605	0.01497	0.01302	0.01129
0.01954	0.01822	0.01698	0.01581	0.01471	0.01367	0.01180	0.01016
0.01819	0.01690	0.01569	0.01456	0.01349	0.01250	0.01071	0.00915
0.01695	0.01569	0.01452	0.01342	0.01240	0.01144	0.00973	0.00825
0.01581	0.01459	0.01345	0.01239	0.01140	0.01048	0.00885	0.00745
0.01476	0.01357	0.01247	0.01144	0.01049	0.00961	0.00805	0.00672
0.01380	0.01264	0.01157	0.01058	0.00967	0.00882	0.00733	0.00607
0.00997	0.00897	0.00806	0.00723	0.00648	0.00580	0.00463	0.00368
0.00732	0.00646	0.00569	0.00500	0.00440	0.00386	0.00295	0.00225
0.00543	0.00470	0.00405	0.00349	0.00301	0.00258	0.00190	0.00139
0.00406	0.00344	0.00291	0.00245	0.00207	0.00174	0.00122	0.00085
0.00305	0.00253	0.00210	0.00173	0.00143	0.00117	0.00079	0.00053
0.00230	0.00187	0.00152	0.00122	0.00099	0.00079	0.00051	0.00032
0.00174	0.00139	0.00110	0.00087	0.00068	0.00054	0.00033	0.00020
0.00132	0.00103	0.00080	0.00061	0.00047	0.00036	0.00021	0.00012
0.00101	0.00076	0.00058	0.00044	0.00033	0.00024	0.00014	0.00007
0.00076	0.00057	0.00042	0.00031	0.00023	0.00016	0.00009	0.00004
0.00058	0.00042	0.00030	0.00022	0.00016	0.00011	0.00005	0.00003
0.00044	0.00031	0.00022	0.00015	0.00011	0.00007	0.00003	0.00001
0.00034	0.00023	0.00016	0.00011	0.00007	0.00005	0.00002	0.00001
0.00026	0.00017	0.00011	0.00008	0.00005	0.00003	0.00001	0.00000

compound interest 5½	6	6½	7	7½	8	9	10
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2.054	2.059	2.064	2.069	2.074	2.079	2.089	2.099
3.168	3.183	3.199	3.214	3.230	3.246	3.278	3.309
4.342	4.374	4.407	4.439	4.472	4.506	4.573	4.640
5.581	5.637	5.693	5.750	5.808	5.866	5.984	6.105
6.888	6.975	7.063	7.153	7.244	7.335	7.523	7.715
8.266	8.393	8.522	8.654	8.787	8.922	9.200	9.487
9.721	9.897	10.076	10.259	10.446	10.636	11.028	11.435
11.256	11.491	11.731	11.977	12.229	12.487	13.021	13.579
12.875	13.180	13.494	13.816	14.147	14.486	15.192	15.937
14.583	14.971	15.371	15.783	16.208	16.645	17.560	18.531
16.385	16.869	17.370	17.888	18.423	18.977	20.140	21.384
18.286	18.882	19.499	20.140	20.805	21.495	22.953	24.522
20.292	21.015	21.767	22.550	23.365	24.214	26.019	27.974
22.408	23.275	24.182	25.129	26.118	27.152	29.360	31.772
24.641	25.672	26.754	27.888	29.077	30.324	33.003	35.949
26.996	28.212	29.493	30.840	32.258	33.750	36.973	40.544
29.481	30.905	32.410	33.999	35.677	37.450	41.301	45.599
32.102	33.759	35.516	37.378	39.358	41.446	46.018	51.159
34.863	36.785	38.825	40.995	43.304	45.761	51.160	57.274
37.786	39.992	42.348	44.865	47.552	50.422	56.764	64.002
40.864	43.392	46.101	49.005	52.118	55.456	62.873	71.402
44.111	46.995	50.098	53.436	57.027	60.893	69.531	79.543
47.537	50.815	54.354	58.176	62.304	66.764	76.789	88.497
51.152	54.864	58.887	63.249	67.977	73.105	84.700	98.347
54.965	59.156	63.715	68.676	74.070	79.954	93.323	109.181
58.989	63.705	68.856	74.483	80.631	87.350	102.723	121.099
63.233	68.528	74.332	80.697	87.679	95.338	112.968	134.209
67.711	73.639	80.164	87.346	95.255	103.965	124.135	148.630
72.435	79.058	86.374	94.460	103.399	113.283	136.307	164.494
100.251	111.434	124.034	138.236	154.251	172.316	215.710	271.024
136.605	154.761	175.631	199.635	227.256	259.056	337.882	442.592
184.119	212.743	246.324	285.749	332.064	386.505	525.858	718.904
246.217	290.335	343.179	406.528	482.529	573.770	815.083	1163.908
327.377	394.172	475.879	575.928	698.542	848.923	1260.091	1880.591
433.450	533.128	657.689	813.520	1008.656	1253.213	1944.791	3034.816
572.083	719.082	906.785	1146.755	1453.865	1847.247	2998.288	4893.706
753.271	967.932	1248.068	1614.134	2093.019	2720.079	4619.223	7887.468
990.076	1300.948	1715.655	2269.657	3010.608	4002.556	7113.232	12708.952
1299.571	1746.599	2356.290	3189.062	4327.926	5886.934	10950.572	20474.000
1704.068	2342.981	3234.016	4478.575	6219.107	8655.705	16854.798	32979.687
2232.730	3141.075	4436.576	6287.185	8934.140	12723.936	25939.182	53120.221
2932.730	4209.103	6084.187	8823.852	12831.922	18701.503	39916.632	85556.753
3826.702	5638.367	8341.557	12381.661	18427.694	27484.515	61422.673	137796.110

Source: Ikupolati and Olaleye (2016)

Table A3: Amount of =N=1 Per Annum Table

Years	2	2½	3	3½	4	4½	Rate per cent 5
1	1.000	1.000	1.000	1.000	1.000	1.000	1.200
2	2.019	2.024	2.029	2.034	2.039	2.044	1.049
3	3.060	3.075	3.090	3.106	3.121	3.137	3.152
4	4.121	4.152	4.183	4.214	4.246	4.278	4.310
5	5.204	5.256	5.309	5.362	5.416	5.470	5.525
6	6.308	6.387	6.468	6.550	6.632	6.716	6.801
7	7.434	7.547	7.662	7.779	7.898	8.019	8.142
8	8.582	8.736	8.892	9.051	9.214	9.380	9.549
9	9.754	9.954	10.159	10.368	10.582	10.802	11.026
10	10.949	10.203	11.463	11.731	12.006	12.288	12.577
11	12.168	12.483	12.807	13.141	13.486	13.841	14.206
12	13.412	13.795	14.192	14.601	15.025	15.464	15.917
13	14.680	15.140	15.617	16.113	16.626	17.159	17.712
14	15.973	16.518	17.086	17.676	18.291	18.932	19.598
15	17.293	17.931	18.598	19.295	20.023	20.784	21.578
16	18.639	19.380	20.156	20.971	21.824	22.719	23.657
17	20.012	20.864	21.761	22.705	23.697	24.741	25.840
18	21.412	22.386	23.414	24.499	25.645	26.855	28.132
19	22.840	23.946	25.116	26.357	27.671	29.063	30.539
20	24.297	25.544	26.870	28.279	29.778	31.371	33.065
21	25.783	27.183	28.676	30.269	31.969	33.783	35.719
22	27.298	28.862	30.536	32.328	34.247	36.303	38.505
23	28.844	30.584	32.452	34.460	36.617	38.937	41.430
24	30.421	32.349	34.426	36.666	39.082	41.689	44.501
25	32.030	34.157	36.459	38.949	41.645	44.565	47.727
26	33.670	36.011	38.553	41.313	44.311	47.570	51.113
27	35.344	37.911	40.709	43.759	47.084	50.711	54.669
28	37.051	39.859	42.930	46.290	49.967	53.993	58.402
29	38.792	41.856	45.218	48.910	52.966	57.423	62.322
30	40.568	43.902	47.575	51.622	56.083	61.007	66.438
35	49.994	54.928	60.462	66.674	73.652	81.496	90.320
40	60.401	67.402	75.401	84.550	95.025	107.030	120.799
45	71.892	81.516	92.719	105.781	121.029	138.849	159.700
50	84.579	97.484	112.796	130.997	152.667	178.503	209.347
55	98.586	115.550	136.071	160.946	191.159	227.917	272.712
60	114.051	135.991	163.053	196.516	237.990	289.497	353.583
65	131.126	159.118	194.332	238.762	294.968	366.237	456.797
70	149.977	185.284	230.594	288.937	364.290	461.869	588.528
75	170.791	214.888	272.630	348.529	448.631	581.044	756.653
80	193.771	248.382	321.362	419.306	551.244	729.557	971.228
85	219.143	286.278	377.856	503.367	676.090	914.632	1245.086
90	247.156	329.154	443.348	603.204	827.983	1145.268	1594.607
95	278.084	377.664	519.271	721.780	1012.784	1432.684	2040.693
100	312.232	432.548	607.287	862.611	1237.623	1790.855	2610.025

compound interest

5½	6	6½	7	7½	8	9	10
0.94786	0.94339	0.93896	0.93457	0.93023	0.92592	0.91743	0.90909
0.89845	0.88999	0.88165	0.87343	0.86533	0.85733	0.84168	0.82644
0.85161	0.83961	0.82784	0.81629	0.80496	0.79383	0.77218	0.75131
0.80721	0.79209	0.77732	0.76289	0.74880	0.73502	0.70842	0.68301
0.76513	0.74725	0.72988	0.71208	0.69655	0.68058	0.64993	0.62092
0.72524	0.70496	0.68933	0.66634	0.64796	0.63016	0.59626	0.56447
0.68743	0.66505	0.64350	0.62274	0.60275	0.58349	0.54703	0.51315
0.65159	0.62741	0.60423	0.58200	0.55070	0.54026	0.50186	0.46650
0.61762	0.59189	0.56735	0.54393	0.52158	0.50024	0.46042	0.42409
0.58543	0.55839	0.53272	0.50834	0.48519	0.46319	0.42241	0.38554
0.55491	0.52678	0.50021	0.47509	0.45134	0.42888	0.38753	0.35049
0.52598	0.49696	0.46968	0.44401	0.41985	0.39711	0.35553	0.31863
0.49856	0.46883	0.44101	0.41496	0.39056	0.36769	0.32617	0.28966
0.47256	0.44230	0.41410	0.38781	0.36331	0.34046	0.29924	0.26333
0.44793	0.41726	0.38882	0.36244	0.33796	0.31524	0.27453	0.23939
0.42458	0.39364	0.36509	0.33873	0.31438	0.29189	0.25186	0.21762
0.40244	0.37136	0.34281	0.31657	0.29245	0.27026	0.23107	0.19784
0.38146	0.35034	0.32188	0.29586	0.27204	0.25024	0.21199	0.17985
0.36157	0.33051	0.30224	0.27650	0.25306	0.23171	0.19448	0.16350
0.34272	0.31180	0.28379	0.25841	0.23541	0.21454	0.17843	0.14864
0.32486	0.29415	0.26647	0.24151	0.21898	0.19865	0.16369	0.13513
0.30792	0.27750	0.25021	0.22571	0.20371	0.18394	0.15018	0.12284
0.29187	0.26179	0.23494	0.21094	0.18949	0.17031	0.13778	0.11167
0.27665	0.24697	0.22060	0.19714	0.17627	0.15769	0.12640	0.10152
0.26223	0.23299	0.20713	0.18424	0.16397	0.14601	0.11596	0.09229
0.24856	0.21981	0.19449	0.17219	0.15253	0.13520	0.10639	0.08390
0.23560	0.20736	0.18262	0.16093	0.14189	0.12518	0.09760	0.07627
0.22332	0.19563	0.17147	0.15040	0.13199	0.11591	0.08954	0.06934
0.21167	0.18455	0.16101	0.14056	0.12278	0.10732	0.08215	0.06303
0.20064	0.17411	0.15118	0.13136	0.11422	0.09937	0.07537	0.05730
0.15351	0.13010	0.11034	0.09366	0.07956	0.06763	0.04898	0.03558
0.11746	0.09722	0.08054	0.06678	0.05541	0.04603	0.03183	0.02209
0.08987	0.07265	0.05878	0.04761	0.03860	0.03132	0.02069	0.01371
0.06876	0.05428	0.04290	0.03394	0.02688	0.02132	0.01344	0.00851
0.05261	0.04056	0.03131	0.02420	0.01872	0.01454	0.00874	0.00528
0.04025	0.03031	0.02285	0.01725	0.01304	0.00987	0.00568	0.00328
0.03080	0.02265	0.01668	0.01230	0.00908	0.00672	0.00369	0.00203
0.02356	0.01692	0.01217	0.00877	0.00633	0.00457	0.00239	0.00126
0.01803	0.01264	0.00888	0.00525	0.00440	0.00311	0.00155	0.00078
0.01379	0.00945	0.00648	0.00445	0.00307	0.00211	0.00101	0.00048
0.01055	0.00706	0.00473	0.00317	0.00213	0.00144	0.00065	0.00030
0.00807	0.00527	0.00345	0.00226	0.00149	0.00098	0.00042	0.00018
0.00618	0.00394	0.00252	0.00161	0.00103	0.00066	0.00027	0.00011
0.00472	0.00294	0.00184	0.00115	0.00072	0.00045	0.00018	0.00007

Source: Ikupolati and Olaleye (2016)

Table A4: Present Value of =N= Table

Years	2	2½	3	3½	4	4½	Rate per cent 5
1	0.98039	0.97560	0.97087	0.96618	0.96153	0.95693	0.95238
2	0.96116	0.95181	0.94259	0.93351	0.92455	0.91573	0.90702
3	0.94232	0.92859	0.91514	0.90194	0.88899	0.87629	0.86383
4	0.92384	0.90595	0.88848	0.87144	0.85480	0.83856	0.82270
5	0.90573	0.88385	0.86260	0.84197	0.82192	0.80245	0.78352
6	0.88797	0.86229	0.83748	0.81350	0.79031	0.76789	0.74621
7	0.87056	0.84126	0.81309	0.78599	0.75991	0.73482	0.71068
8	0.85349	0.82074	0.78940	0.75941	0.73069	0.70318	0.67683
9	0.83675	0.80072	0.76641	0.73373	0.70258	0.67290	0.64460
10	0.82034	0.78119	0.74409	0.70891	0.67556	0.64392	0.61391
11	0.80426	0.76214	0.72242	0.68494	0.64958	0.61619	0.58467
12	0.78849	0.74355	0.70137	0.66178	0.62459	0.58966	0.55683
13	0.77303	0.72542	0.68095	0.63940	0.60057	0.56427	0.53032
14	0.75787	0.70772	0.66111	0.61778	0.57747	0.53997	0.50506
15	0.74301	0.69046	0.64186	0.59689	0.55526	0.51672	0.48101
16	0.72844	0.67362	0.62316	0.57670	0.53390	0.49446	0.45811
17	0.71416	0.65719	0.60501	0.55720	0.51337	0.47317	0.43629
18	0.70015	0.64116	0.58739	0.53836	0.49362	0.45280	0.41552
19	0.68643	0.62552	0.57028	0.52015	0.47464	0.43330	0.39573
20	0.67297	0.61027	0.55367	0.50256	0.45638	0.41464	0.37688
21	0.65977	0.59538	0.53754	0.48557	0.43383	0.39678	0.35894
22	0.64683	0.58086	0.52189	0.46915	0.42195	0.37970	0.34184
23	0.63415	0.56669	0.50669	0.45328	0.40572	0.36335	0.32557
24	0.62172	0.55287	0.49193	0.43795	0.39012	0.34770	0.31006
25	0.60953	0.53939	0.47760	0.42314	0.37511	0.33273	0.29530
26	0.59757	0.52623	0.46369	0.40883	0.36068	0.31840	0.28124
27	0.58586	0.51339	0.45018	0.39501	0.34681	0.30469	0.26784
28	0.57437	0.50087	0.43707	0.38165	0.33347	0.29157	0.25509
29	0.56311	0.48866	0.42434	0.36874	0.32065	0.27901	0.24294
30	0.55207	0.47674	0.41198	0.35627	0.30831	0.26700	0.23137
35	0.50002	0.42137	0.35538	0.29997	0.25341	0.21425	0.18129
40	0.45289	0.37243	0.30655	0.25257	0.20828	0.17192	0.14204
45	0.41019	0.32917	0.26443	0.21265	0.17119	0.13796	0.11129
50	0.37152	0.29094	0.22810	0.17905	0.14071	0.11070	0.08720
55	0.33650	0.25715	0.19676	0.15075	0.11565	0.08883	0.06832
60	0.30478	0.22728	0.16973	0.12693	0.09506	0.07128	0.05353
65	0.27605	0.20088	0.14641	0.10687	0.07813	0.05720	0.04194
70	0.25002	0.17755	0.12629	0.08998	0.06421	0.04590	0.03286
75	0.22645	0.15693	0.10894	0.07576	0.05278	0.03683	0.02575
80	0.20510	0.13870	0.09397	0.06379	0.04338	0.02955	0.02017
85	0.18577	0.12259	0.08106	0.05371	0.03565	0.02372	0.01580
90	0.16826	0.10835	0.06992	0.04522	0.02930	0.01903	0.01238
95	0.15239	0.09577	0.06032	0.03807	0.02408	0.01527	0.00970
100	0.13803	0.08464	0.05203	0.03206	0.01980	0.01225	0.00760

compound interest 5½	6	6½	7	7½	8	9	10
1.0550	1.0600	1.0650	1.0700	1.0750	1.0800	1.0900	1.1000
1.1130	1.1235	1.1342	1.1448	1.1556	1.1663	1.1880	1.2099
1.1742	1.1910	1.2079	1.2250	1.2422	1.2597	1.2950	1.3309
1.2388	1.2624	1.2864	1.3107	1.3354	1.3604	1.4115	1.4640
1.3069	1.3382	1.3700	1.4025	1.4356	1.4693	1.5386	1.6105
1.3788	1.4185	1.4591	1.5007	1.5433	1.5868	1.6771	1.7715
1.4546	1.5036	1.5589	1.6057	1.6590	1.7138	1.8280	1.9487
1.5346	1.5938	1.6549	1.7181	1.7834	1.8509	1.9925	2.1435
1.6190	1.6894	1.7625	1.8384	1.9172	1.9990	2.1718	2.3579
1.7081	1.7908	1.8771	1.9671	2.0610	2.1581	2.3673	2.5937
1.8020	1.8982	1.9991	2.1048	2.2156	2.3316	2.5804	2.8531
1.9012	2.0121	2.1290	2.2521	2.3817	2.5189	2.8126	3.1384
2.0057	2.1329	2.2674	2.4098	2.5604	2.7196	3.0658	3.4522
2.1160	2.2609	2.4148	2.5785	2.7524	2.9371	3.3417	3.7974
2.2324	2.3965	2.5718	2.7590	2.9588	3.1721	3.6424	4.1772
2.3552	2.5403	2.7390	2.9521	3.1807	3.4259	3.9703	4.5949
2.4848	2.6927	2.9170	3.1588	3.4193	3.7000	4.3276	5.0544
2.6214	2.8543	3.1066	3.3799	3.6758	3.9960	4.7171	5.5599
2.7656	3.0255	3.3085	3.6165	3.9514	4.3157	5.1416	6.1159
2.9177	3.2071	3.5236	3.8696	4.2478	4.6609	5.6044	6.7274
3.0782	3.3995	3.7526	4.1405	4.5664	5.0338	6.1088	7.4002
3.2475	3.6035	3.9966	4.4304	4.9089	5.4365	6.6586	8.1402
3.4261	3.8197	4.2563	4.7405	5.2770	5.8714	7.2578	8.9543
3.6145	4.0489	4.5330	5.0723	5.6728	6.3411	7.9110	9.8497
3.8133	4.2918	4.8276	5.4274	6.0983	6.8484	8.6230	10.8347
4.0231	4.5493	5.1414	5.8073	6.5557	7.3963	9.3991	11.9181
4.2444	4.8223	5.4756	6.2138	7.0473	7.9880	10.2450	13.1099
4.4778	5.1116	5.8316	6.6488	7.5759	8.6271	11.1671	14.4209
4.7241	5.4183	6.2106	7.1142	8.1441	9.3172	12.1721	15.8630
4.9839	5.7434	6.6143	7.6122	8.7549	10.0626	13.2676	17.4494
6.5138	7.6860	9.0622	10.6765	12.5688	14.7853	20.4139	28.1024
8.5133	10.2857	12.4160	14.9744	18.0442	21.7245	31.4094	45.2592
11.1265	13.7646	17.0110	21.0024	25.9048	31.9204	48.3272	72.8904
14.5419	18.4201	23.3066	29.4570	37.1897	46.9016	74.3575	117.3908
19.0057	24.6503	31.9321	41.3149	53.3906	68.9138	114.4082	189.0591
24.8397	32.9876	43.7498	57.9464	76.6492	101.2570	176.0312	304.4816
32.4645	44.1449	59.9410	81.2728	110.0398	148.7798	270.8459	490.3706
42.4299	59.0759	82.1244	113.9893	157.9764	218.6063	416.7300	789.7468
55.4542	79.0569	112.5176	159.8760	226.7956	321.2045	641.1908	1271.8952
72.4764	105.7959	154.1589	224.2343	325.5945	471.9547	986.5515	2048.4000
94.7237	141.5788	211.2110	314.5002	467.4330	693.4564	1517.9319	3298.9687
123.8002	189.4645	289.3774	441.1029	671.0605	1018.9149	2335.5264	5313.0221
161.8019	253.5462	396.4721	618.6696	963.3942	1497.1203	3593.4969	8556.6753
211.4686	339.3020	543.2012	867.7162	1383.0771	2199.7612	5529.0406	13780.6110

Source: Ikupolati and Olaleye (2016)

Table A5: Amount of =N=1 Table

Years	2	2½	3	3½	4	4½	Rate per cent 5
1	1.0200	1.0250	1.0300	1.0350	1.0400	1.0450	1.0500
2	1.0403	1.0506	1.0608	1.0712	1.0815	1.0920	1.1024
3	1.0612	1.0768	1.0927	1.1087	1.1248	1.1411	1.1576
4	1.0824	1.1038	1.1255	1.1475	1.1698	1.1925	1.2155
5	1.1040	1.1314	1.1592	1.1876	1.2166	1.2461	1.2762
6	1.1261	1.1596	1.1940	1.2292	1.2653	1.3022	1.3400
7	1.1486	1.1886	1.2298	1.2722	1.3159	1.3608	1.4071
8	1.1716	1.2184	1.2667	1.3168	1.3685	1.4221	1.4774
9	1.1950	1.2488	1.3047	1.3628	1.4233	1.4860	1.5513
10	1.2189	1.2800	1.3439	1.4105	1.4802	1.5529	1.6288
11	1.2433	1.3120	1.3842	1.4599	1.5394	1.6228	1.7103
12	1.2682	1.3448	1.4257	1.5110	1.6010	1.6958	1.7958
13	1.2936	1.3785	1.4685	1.5639	1.6650	1.7721	1.8856
14	1.3194	1.4129	1.5125	1.6186	1.7316	1.8519	1.9799
15	1.3458	1.4482	1.5579	1.6753	1.8009	1.9352	2.0789
16	1.3727	1.4845	1.6047	1.7339	1.8729	2.0223	2.1828
17	1.4002	1.5216	1.6528	1.7946	1.9479	2.1133	2.2920
18	1.4282	1.5596	1.7024	1.8574	2.0258	2.2084	2.4066
19	1.4568	1.5986	1.7535	1.9225	2.1068	2.3078	2.5269
20	1.4859	1.6386	1.8061	1.9897	2.1911	2.4117	2.6532
21	1.5156	1.6795	1.8602	2.0594	2.2787	2.5202	2.7859
22	1.5459	1.7215	1.9161	2.1315	2.3699	2.6336	2.9252
23	1.5768	1.7646	1.9735	2.2061	2.4647	2.7521	3.0715
24	1.6084	1.8087	2.0327	2.2833	2.5633	2.8760	3.2250
25	1.6406	1.8539	2.0937	2.3632	2.6658	3.0054	3.3863
26	1.6734	1.9002	2.1565	2.4459	2.7724	3.1406	3.5556
27	1.7068	1.9477	2.2212	2.5315	2.8833	3.2820	3.7834
28	1.7410	1.9964	2.2879	2.6201	2.9987	3.4296	3.9201
29	1.7758	2.0464	2.3565	2.7118	3.1180	3.5840	4.1161
30	1.8113	2.0975	2.4272	2.8067	3.2433	3.7453	4.3219
35	1.9998	2.3732	2.8138	3.3335	3.9460	4.6673	5.5160
40	2.2080	2.6850	3.2620	3.9592	4.8010	5.8163	7.0399
45	2.4378	3.0379	3.7815	4.7023	5.8411	7.2482	8.9850
50	2.6915	3.4371	4.3839	5.5849	7.1066	9.0326	11.4673
55	2.9717	3.8887	5.0821	6.6331	8.6463	11.2563	14.6356
60	3.2810	4.3997	5.8916	7.8780	10.5196	14.0274	18.6791
65	3.6225	4.9779	6.8299	9.3566	12.7987	17.4807	23.8398
70	3.9995	5.6321	7.9178	11.1128	15.5716	21.7841	30.4264
75	4.4158	6.3722	9.1789	13.1985	18.9452	27.1469	38.8326
80	4.8754	7.2095	10.6408	15.6757	23.0497	33.8300	49.5614
85	5.3828	8.1569	12.3357	18.6178	28.0436	42.1584	63.2543
90	5.9431	9.2288	14.3004	22.1121	34.1193	52.5371	80.7303
95	6.5616	10.4416	16.5781	26.2623	41.5113	65.4707	103.6346
100	7.2446	11.8137	19.2186	31.1914	50.5049	81.5885	131.5012

compound interest 5½	6	6½	7	7½	8	9	10
0.9478	0.9433	0.9389	0.9345	0.9302	0.9259	0.9174	0.9090
1.8463	1.8333	1.8206	1.8080	1.7956	1.7832	1.7591	1.7355
2.6979	2.6730	2.6484	2.6243	2.6003	2.5770	2.5312	2.4868
3.5051	3.4651	3.4257	3.3872	3.3493	3.3121	3.2397	3.1698
4.2702	4.2123	4.1556	4.1001	4.0458	3.9927	3.8896	3.7907
4.9955	4.9178	4.8410	4.7665	4.6938	4.6228	4.4859	4.3552
5.6829	5.5823	5.4845	5.3892	5.2966	5.2063	5.0329	4.8684
6.3345	6.2097	6.0887	5.9712	5.8573	5.7466	5.5348	5.3349
6.9521	6.8016	6.6561	6.5152	6.3788	6.2468	5.9952	5.7590
7.5376	7.3600	7.1888	7.0235	6.8640	6.7100	6.4176	6.1445
8.0925	7.8868	7.6890	7.4986	7.3154	7.1389	6.8051	6.4950
8.6185	8.3838	8.1587	7.9426	7.7352	7.5360	7.1607	6.8136
9.1176	8.8526	8.5997	8.3576	8.1258	7.9037	7.4869	7.1033
9.5896	9.2949	9.0138	8.7454	8.4891	8.2442	7.7861	7.3666
10.0375	9.7122	9.4026	9.1079	8.8271	8.5594	8.0606	7.6060
10.4621	10.1058	9.7677	9.4465	9.1415	8.8513	8.3125	7.8237
10.8646	10.4772	10.1105	9.7632	9.4339	9.1216	8.5436	8.0215
11.2460	10.8276	10.4324	10.0590	9.7060	9.3718	8.7556	8.2014
11.6076	11.1581	10.7347	10.3355	9.9590	9.6035	8.9501	8.3649
11.9503	11.4690	11.0185	10.5940	10.1944	9.8181	9.1285	8.5135
12.2752	11.7640	11.2849	10.8355	10.4134	10.0168	9.2922	8.6486
12.5831	12.0415	11.5351	11.0612	10.6171	10.2007	9.4424	8.7715
12.8750	12.3033	11.7701	11.2721	10.8066	10.3710	9.5802	8.8832
13.1516	12.5503	11.9907	11.4693	10.9829	10.5287	9.7066	8.9847
13.4139	12.7833	12.1978	11.6535	11.1459	10.6747	9.8225	9.0770
13.6824	13.0031	12.3923	11.8257	11.2994	10.8099	9.9289	9.1609
13.8980	13.2105	12.5749	11.9867	11.4413	10.9351	10.0265	9.2372
14.1214	13.4061	12.7464	12.1371	11.5733	11.0510	10.1161	9.3065
14.3331	13.5907	12.9074	12.2776	11.6961	11.1584	10.1982	9.3696
14.5837	13.7648	13.0586	12.4090	11.8103	11.2577	10.2736	9.4296
15.3905	14.4982	13.6869	12.9476	12.2725	11.6545	10.5668	9.6441
16.0461	15.0462	14.1455	13.3317	12.5944	11.9246	10.7573	9.7790
16.5477	15.4558	14.4802	13.6055	12.8186	12.1084	10.8811	9.8628
16.9315	15.7618	14.7246	13.8007	12.9748	12.2334	10.9616	9.9148
17.2251	15.9905	14.9028	13.9399	13.0836	12.3186	11.0139	9.9471
17.4498	16.1614	15.0329	14.0391	13.1593	12.3765	11.0479	9.9671
17.6217	16.2891	15.1279	14.1099	13.2121	12.4159	11.0700	9.9796
17.7533	16.3845	15.1972	14.1603	13.2489	12.4428	11.0844	9.9873
17.8539	16.4558	15.2478	14.1963	13.2745	12.4610	11.0937	9.9921
17.9309	16.5091	15.2848	14.2220	13.2923	12.4735	11.0998	9.9951
17.9898	16.5489	15.3117	14.2402	13.3048	12.4819	11.1037	9.9969
18.0348	16.5786	15.3314	14.2533	13.3134	12.4877	11.1063	9.9981
18.0694	16.6009	15.3458	14.2626	13.3194	12.4916	11.1080	9.9988
18.0958	16.6175	15.3562	14.2692	13.3236	12.4943	11.1091	9.9992

Source: Ikupolati and Olaleye (2016)

Table A6: 2 ½ % Compound Interest Factors

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TABLE A–2 2½% Compound Interest Factors

	SINGLE PAYMENT		UNIFORM SERIES				
n	Compound Amount Factor F → P	Present Worth Factor P → F	Sinking Fund Factor A → F	Capital Recovery Factor A → P	Compound Amount Factor F → A	Present Worth Factor P → A	n
1	1.0250	0.9756	1.00000	0.02500	1.000	0.976	1
2	1.0506	0.9518	0.49383	0.51883	2.025	1.927	2
3	1.0769	0.9286	0.32514	0.35014	3.076	2.856	3
4	1.1038	0.9060	0.24082	0.26582	4.153	3.762	4
5	1.1314	0.8839	0.19025	0.21525	5.256	4.646	5
6	1.1597	0.8623	0.15655	0.18155	6.388	5.508	6
7	1.1887	0.8413	0.13250	0.15750	7.547	6.349	7
8	1.2184	0.8207	0.11447	0.13947	8.736	7.170	8
9	1.2489	0.8007	0.10046	0.12546	9.955	7.971	9
10	1.2801	0.7812	0.08926	0.11426	11.203	8.752	10
11	1.3121	0.7621	0.08011	0.10511	12.483	9.514	11
12	1.3449	0.7436	0.07249	0.09749	13.796	10.258	12
13	1.3785	0.7254	0.06605	0.09105	15.140	10.983	13
14	1.4130	0.7077	0.06054	0.08554	16.519	11.691	14
15	1.4483	0.6905	0.05577	0.08077	17.932	12.381	15
16	1.4845	0.6736	0.05160	0.07660	19.380	13.055	16
17	1.5216	0.6572	0.04793	0.07293	20.865	13.712	17
18	1.5597	0.6412	0.04467	0.06967	22.386	14.353	18
19	1.5987	0.6255	0.04176	0.06676	23.946	14.979	19
20	1.6386	0.6103	0.03915	0.06415	25.545	15.589	20
21	1.6796	0.5954	0.03679	0.06179	27.183	16.185	21
22	1.7216	0.5809	0.03465	0.05965	28.863	16.765	22
23	1.7646	0.5667	0.03270	0.05770	30.584	17.332	23
24	1.8087	0.5529	0.03091	0.05591	32.349	17.885	24
25	1.8539	0.5394	0.02928	0.05428	34.158	18.424	25
26	1.9003	0.5262	0.02777	0.05277	36.012	18.951	26
27	1.9478	0.5134	0.02638	0.05138	37.912	19.464	27
28	1.9965	0.5009	0.02509	0.05009	39.860	19.965	28
29	2.0464	0.4887	0.02389	0.04889	41.856	20.454	29
30	2.0976	0.4767	0.02278	0.04778	43.903	20.930	30
31	2.1500	0.4651	0.02174	0.04674	46.000	21.395	31
32	2.2038	0.4538	0.02077	0.04577	48.150	21.849	32
33	2.2589	0.4427	0.01986	0.04486	50.354	22.292	33
34	2.3153	0.4319	0.01901	0.04401	52.613	22.724	34
35	2.3732	0.4214	0.01821	0.04321	54.928	23.145	35
40	2.6851	0.3724	0.01484	0.03984	67.403	25.103	40
45	3.0379	0.3292	0.01227	0.03727	81.516	26.833	45
50	3.4371	0.2909	0.01026	0.03526	97.484	28.362	50
55	3.8888	0.2572	0.00865	0.03365	115.551	29.714	55
60	4.3998	0.2273	0.00735	0.03235	135.992	30.909	60
65	4.9780	0.2009	0.00628	0.03128	159.118	31.965	65
70	5.6321	0.1776	0.00540	0.03040	185.284	32.898	70
75	6.3722	0.1569	0.00465	0.02965	214.888	33.723	75
80	7.2100	0.1387	0.00403	0.02903	248.383	34.452	80
85	8.1570	0.1226	0.00349	0.02849	286.279	35.096	85
90	9.2289	0.1084	0.00304	0.02804	329.154	35.666	90
95	10.4416	0.0958	0.00265	0.02765	377.664	36.169	95
100	11.8137	0.0846	0.00231	0.02731	432.549	36.614	100

Source: WAEC (1992)

Table A7: 3% Compound Interest Factors

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TABLE A-3 3% Compound Interest Factors

n	Single Payment: Compound Amount Factor F → P	Single Payment: Present Worth Factor P → F	Uniform Series: Sinking Fund Factor A → F	Uniform Series: Capital Recovery Factor A → P	Uniform Series: Compound Amount Factor F → A	Uniform Series: Present Worth Factor P → A	n
1	1.0300	0.9709	1.00000	1.03000	1.000	0.971	1
2	1.0609	0.9426	0.49261	0.52261	2.030	1.913	2
3	1.0927	0.9151	0.32353	0.35353	3.091	2.829	3
4	1.1255	0.8885	0.23903	0.26903	4.184	3.717	4
5	1.1593	0.8626	0.18835	0.21835	5.309	4.580	5
6	1.1941	0.8375	0.15460	0.18460	6.468	5.417	6
7	1.2299	0.8131	0.13051	0.16051	7.662	6.230	7
8	1.2668	0.7894	0.11246	0.14246	8.892	7.020	8
9	1.3048	0.7664	0.09843	0.12843	10.159	7.786	9
10	1.3439	0.7441	0.08723	0.11723	11.464	8.530	10
11	1.3842	0.7224	0.07808	0.10808	12.808	9.253	11
12	1.4258	0.7014	0.07046	0.10046	14.192	9.954	12
13	1.4685	0.6810	0.06403	0.09403	15.618	10.635	13
14	1.5126	0.6611	0.05853	0.08853	17.086	11.296	14
15	1.5580	0.6419	0.05377	0.08377	18.599	11.938	15
16	1.6047	0.6232	0.04961	0.07961	20.157	12.561	16
17	1.6528	0.6050	0.04595	0.07595	21.762	13.166	17
18	1.7024	0.5874	0.04271	0.07271	23.414	13.754	18
19	1.7535	0.5703	0.03981	0.06981	25.117	14.324	19
20	1.8061	0.5537	0.03722	0.06722	26.870	14.877	20
21	1.8603	0.5375	0.03487	0.06487	28.676	15.415	21
22	1.9161	0.5219	0.03275	0.06275	30.537	15.937	22
23	1.9736	0.5067	0.03081	0.06081	32.453	16.444	23
24	2.0328	0.4919	0.02905	0.05905	34.426	16.936	24
25	2.0938	0.4776	0.02743	0.05743	36.459	17.413	25
26	2.1566	0.4637	0.02594	0.05594	38.553	17.877	26
27	2.2213	0.4502	0.02456	0.05456	40.710	18.327	27
28	2.2879	0.4371	0.02329	0.05329	42.931	18.764	28
29	2.3566	0.4243	0.02211	0.05211	45.219	19.188	29
30	2.4273	0.4120	0.02102	0.05102	47.575	19.600	30
31	2.5001	0.4000	0.02000	0.05000	50.003	20.000	31
32	2.5751	0.3883	0.01905	0.04905	52.503	20.389	32
33	2.6523	0.3770	0.01816	0.04816	55.078	20.766	33
34	2.7319	0.3660	0.01732	0.04732	57.730	21.132	34
35	2.8139	0.3554	0.01654	0.04654	60.462	21.487	35
40	3.2620	0.3066	0.01326	0.04326	75.401	23.115	40
45	3.7816	0.2644	0.01079	0.04079	92.720	24.519	45
50	4.3839	0.2281	0.00887	0.03887	112.797	25.730	50
55	5.0821	0.1968	0.00735	0.03735	136.072	26.774	55
60	5.8916	0.1697	0.00613	0.03613	163.053	27.676	60
65	6.8300	0.1464	0.00515	0.03515	194.333	28.453	65
70	7.9178	0.1263	0.00434	0.03434	230.594	29.123	70
75	9.1789	0.1089	0.00367	0.03367	272.631	29.702	75
80	10.6409	0.0940	0.00311	0.03311	321.363	30.201	80
85	12.3357	0.0811	0.00265	0.03265	377.857	30.631	85
90	14.3005	0.0699	0.00226	0.03226	443.349	31.002	90
95	16.5782	0.0603	0.00193	0.03193	519.272	31.323	95
100	19.2186	0.0520	0.00165	0.03165	607.288	31.599	100

Source: WAEC (1992)

Table A8: 6% Compound Interest Factors

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TABLE A-7 6% Compound Interest Factors

n	Single Payment: Compound Amount Factor F — P	Single Payment: Present Worth Factor P — F	Uniform Series: Sinking Fund Factor A — F	Uniform Series: Capital Recovery Factor A — P	Uniform Series: Compound Amount Factor F — A	Uniform Series: Present Worth Factor P — A	n
1	1.0600	0.9434	1.00000	1.06000	1.000	0.943	1
2	1.1236	0.8900	0.48544	0.54544	2.060	1.833	2
3	1.1910	0.8396	0.31411	0.37411	3.184	2.673	3
4	1.2625	0.7921	0.22859	0.28859	4.375	3.465	4
5	1.3382	0.7473	0.17740	0.23740	5.637	4.212	5
6	1.4185	0.7050	0.14336	0.20336	6.975	4.917	6
7	1.5036	0.6651	0.11914	0.17914	8.394	5.582	7
8	1.5938	0.6274	0.10104	0.16104	9.897	6.210	8
9	1.6895	0.5919	0.08702	0.14702	11.491	6.802	9
10	1.7908	0.5584	0.07587	0.13587	13.181	7.360	10
11	1.8983	0.5268	0.06679	0.12679	14.972	7.887	11
12	2.0122	0.4970	0.05928	0.11928	16.870	8.384	12
13	2.1329	0.4688	0.05296	0.11296	18.882	8.853	13
14	2.2609	0.4423	0.04758	0.10758	21.015	9.295	14
15	2.3966	0.4173	0.04296	0.10296	23.276	9.712	15
16	2.5404	0.3936	0.03895	0.09895	25.673	10.106	16
17	2.6928	0.3714	0.03544	0.09544	28.213	10.477	17
18	2.8543	0.3503	0.03236	0.09236	30.906	10.828	18
19	3.0256	0.3305	0.02962	0.08962	33.760	11.158	19
20	3.2071	0.3118	0.02718	0.08718	36.786	11.470	20
21	3.3996	0.2942	0.02500	0.08500	39.993	11.764	21
22	3.6035	0.2775	0.02305	0.08305	43.392	12.042	22
23	3.8197	0.2618	0.02128	0.08128	46.996	12.303	23
24	4.0489	0.2470	0.01968	0.07968	50.816	12.550	24
25	4.2919	0.2330	0.01823	0.07823	54.865	12.783	25
26	4.5494	0.2198	0.01690	0.07690	59.156	13.003	26
27	4.8223	0.2074	0.01570	0.07570	63.706	13.211	27
28	5.1117	0.1956	[illegible]	[illegible]	68.528	13.406	28
29	[illegible]	[illegible]	0.01358	0.07358	73.640	13.591	29
30	5.7435	0.1741	0.01265	0.07265	79.058	13.765	30
31	[illegible]	[illegible]	0.01179	0.07179	84.802	13.929	31
32	6.4534	0.1550	0.01100	0.07100	90.890	14.084	32
33	6.8406	0.1462	0.01027	0.07027	97.343	14.230	33
34	7.2510	0.1379	0.00960	0.06960	104.184	14.368	34
35	7.6861	0.1301	0.00897	0.06897	111.435	14.498	35
40	10.2857	0.0972	0.00646	0.06646	154.762	15.046	40
45	13.7646	0.0727	0.00470	0.06470	212.744	15.456	45
50	18.4202	0.0543	0.00344	0.06344	290.336	15.762	50
55	24.6503	0.0406	0.00254	0.06254	394.172	15.991	55
60	32.9877	0.0303	0.00188	0.06188	533.128	16.161	60
65	44.1450	0.0227	0.00139	0.06139	719.083	16.289	65
70	59.0759	0.0169	0.00103	0.06103	967.932	16.385	70
75	79.0569	0.0126	0.00077	0.06077	1,300.949	16.456	75
80	105.7960	0.0095	0.00057	0.06057	1,746.600	16.509	80
85	141.5789	0.0071	0.00043	0.06043	2,342.982	16.549	85
90	189.4645	0.0053	0.00032	0.06032	3,141.075	16.579	90
95	253.5463	0.0039	0.00024	0.06024	4,209.104	16.601	95
100	339.3021	0.0029	0.00018	0.06018	5,638.368	16.618	100

Source: WAEC (1992)

Table A9: 7% Compound Interest Factors

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TABLE A– 8 7% Compound Interest Factors

	SINGLE PAYMENT		UNIFORM SERIES				
n	Compound Amount Factor $F \longrightarrow P$	Present Worth Factor $P \longrightarrow F$	Sinking Fund Factor $A \longrightarrow F$	Capital Recovery Factor $A \longrightarrow F$	Compound Amount Factor $F \longrightarrow A$	Present Worth Factor $P \longrightarrow A$	n
1	1.0700	0.9346	1.00000	1.07000	1.000	0.935	1
2	1.1449	0.8734	0.48309	0.55309	2.070	1.808	2
3	1.2250	0.8163	0.31105	0.38105	3.215	2.624	3
4	1.3108	0.7629	0.22523	0.29523	4.440	3.387	4
5	1.4026	0.7130	0.17389	0.24389	5.751	4.100	5
6	1.5007	0.6663	0.13980	0.20980	7.153	4.767	6
7	1.6058	0.6227	0.11555	0.18555	8.654	5.389	7
8	1.7182	0.5820	0.09747	0.16747	10.260	5.971	8
9	1.8385	0.5439	0.08349	0.15349	11,978	6.515	9
10	1.9672	0.5083	0.07238	0.14238	13.816	7.024	10
11	2.1049	0.4751	0.06336	0.13336	15.784	7.499	11
12	2.2522	0.4440	0.05590	0.12590	17.888	7.943	12
13	2.4098	0.4150	0.04965	0.11965	20.141	8.358	13
14	2.5785	0.3878	0.04434	0.11434	22.550	8.745	14
15	2.7590	0.3624	0.03979	0.10979	25.129	9.108	15
16	2.9522	0.3387	0.03586	0.10586	27.888	9.447	16
17	3.1588	0.3166	0.03243	0.10243	30.840	9.763	17
18	3.3799	0.2959	0.02941	0.09941	33.999	10.059	18
19	3.6165	0.2765	0.02675	0.09675	37.379	10.336	19
20	3.8697	0.2584	0.02439	0.09439	40.995	10.594	20
21	4.1406	0.2415	0.02229	0.09229	44.865	10.836	21
22	4.4304	0.2257	0.02041	0.09041	49.006	11.061	22
23	4.7405	0.2109	0.01871	0.08871	53.436	11.272	23
24	5.0724	0.1971	0.01719	0.08719	58.177	11.469	24
25	5.4274	0.1842	0.01581	0.08581	63.249	11.654	25
26	5.8074	0.1722	0.01456	0.08456	68.676	11.826	26
27	6.2139	0.1609	0.01343	0.08343	74.484	11.987	27
28	6.6488	0.1504	0.01239	0.08239	80.698	12.137	28
29	7.1143	0.1406	0.01145	0.08145	87.347	12.278	29
30	7.6123	0.1314	0.01059	0.08059	94.461	12.409	30
31	8.1451	0.1228	0.00980	0.07980	102.073	12.532	31
32	8.7153	0.1147	0.00907	0.07907	110.218	12.647	32
33	9.3253	0.1072	0.00841	0.07841	118.933	12.754	33
34	9.9781	0.1002	0.00780	0.07780	128.259	12.854	34
35	10.6766	0.0937	0.00723	0.07723	138.237	12.948	35
40	14.9745	0.0668	0.00501	0.07501	199.635	13.332	40
45	21.0025	0.0476	0.00350	0.07350	285.749	13.606	45
50	29.4570	0.0339	0.00246	0.07246	406.529	13.801	50
55	41.3150	0.0242	0.00174	0.07174	575.929	13.940	55
60	57.9464	0.0173	0.00123	0.07123	813.520	14.039	60
65	81.2729	0.0123	0.00087	0.07087	1,146.755	14.110	65
70	113.9894	0.0088	0.00062	0.07062	1,614.134	14.160	70
75	159.8760	0.0063	0.00044	0.07044	2,269.557	14.196	75
80	224.2344	0.0045	0.00031	0.00031	3,189.063	14.222	80
85	314.5003	0.0032	0.00022	0.07022	4,478.576	14.240	85
90	441.1030	0.0023	0.00016	0.07016	6,287.185	14.253	90
95	618.6697	0.0016	0.00011	0.07011	8,823.854	14.263	95
100	867.7163	0.0012	0.00008	0.07008	12,381.862	14.269	100

Source: WAEC (1992)

Table A10: 10% Compound Interest Factors

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TABLE A-10 10% Compound Interest Factors

	SINGLE PAYMENT		UNIFORM SERIES				
n	Compound Amount Factor F → P	Present Worth Factor P → F	Sinking Fund Factor A → F	Capital Recovery Factor A → P	Compound Amount Factor F → A	Present Worth Factor P → A	n
1	1.1000	0.9091	1.00000	1.10000	1.000	0.909	1
2	1.2100	0.8264	0.47619	0.57619	2.100	1.736	2
3	1.3310	0.7513	0.30211	0.40211	3.310	2.487	3
4	1.4641	0.6830	0.21547	0.31547	4.641	3.170	4
5	1.6105	0.6209	0.16380	0.26380	6.105	3.791	5
6	1.7716	0.5645	0.12961	0.22961	7.716	4.355	6
7	1.9487	0.5132	0.10541	0.20541	9.487	4.868	7
8	2.1436	0.4665	0.08744	0.18744	11.436	5.335	8
9	2.3579	0.4241	0.07364	0.17364	13.579	5.759	9
10	2.5937	0.3855	0.06275	0.16275	15.937	6.144	10
11	2.8531	0.3505	0.05396	0.15396	18.531	6.495	11
12	3.1384	0.3186	0.04676	0.14676	21.384	6.814	12
13	3.4523	0.2897	0.04078	0.14078	24.523	7.103	13
14	3.7975	0.2633	0.03575	0.13575	27.975	7.367	14
15	4.1772	0.2394	0.03147	0.13147	31.772	7.606	15
16	4.5950	0.2176	0.02782	0.12782	35.950	7.824	16
17	5.0545	0.1978	0.02466	0.12466	40.545	8.022	17
18	5.5599	0.1799	0.02193	0.12193	45.599	8.201	18
19	6.1159	0.1635	0.01955	0.11955	51.159	8.365	19
20	6.7275	0.1486	0.01746	0.11746	57.275	8.514	20
21	7.4002	0.1351	0.01562	0.11562	64.002	8.649	21
22	8.1403	0.1228	0.01401	0.11401	71.403	8.772	22
23	8.9543	0.1117	0.01257	0.11257	79.543	8.883	23
24	9.8497	0.1015	0.01130	0.11130	88.497	8.985	24
25	10.8347	0.0923	0.01017	0.11017	98.347	9.077	25
26	11.9182	0.0839	0.00916	0.10916	109.182	9.161	26
27	13.1100	0.0763	0.00826	0.10826	121.100	9.237	27
28	14.4210	0.0693	0.00745	0.10745	134.210	9.307	28
29	15.8631	0.0630	0.00673	0.10673	148.631	9.370	29
30	17.4494	0.0573	0.00608	0.10608	164.494	9.427	30
31	19.1943	0.0521	0.00550	0.10550	181.943	9.479	31
32	21.1138	0.0474	0.00497	0.10497	201.138	9.526	32
33	23.2252	0.0431	0.00460	0.10450	222.252	9.569	33
34	25.5477	0.0391	0.00407	0.10407	245.477	9.609	34
35	28.1024	0.0356	0.00369	0.10369	271.024	9.644	35
40	45.2593	0.0221	0.00226	0.10226	442.593	9.779	40
45	72.8905	0.0137	0.00139	0.10139	718.905	9.863	45
50	117.3909	0.0085	0.00086	0.10086	1,163.909	9.915	50
55	189.0591	0.0053	0.00053	0.10053	1,880.591	9.947	55
60	304.4816	0.0033	0.00033	0.10033	3,034.816	9.967	60
65	490.3707	0.0020	0.00020	0.10020	4,893.707	9.980	65
70	789.7470	0.0013	0.00013	0.10013	7,887.470	9.987	70
75	1,271.8952	0.0008	0.00008	0.10008	12,708.954	9.992	75
80	2,048.4002	0.0005	0.00005	0.10005	20,474.002	9.995	80
85	3,298.9690	0.0003	0.00003	0.10003	32,979.690	9.997	85
90	5,313.0226	0.0002	0.00002	0.10002	53,120.226	9.998	90
95	8,556.0760	0.0001	0.00001	0.10001	85,556.760	9.999	95
100	13,780.6123	0.0001	0.00001	0.10001	137,796.123	9.999	100

Source: WAEC (1992)

Table A11: 12% Compound Interest Factors

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TABLE A–11 12% Compound Interest Factors

	SINGLE PAYMENT		UNIFORM SERIES				
n	Compound Amount Factor F ⟶ P	Present Worth Factor P ⟶ F	Sinking Fund Factor A ⟶ F	Capital Recovery Factor A ⟶ P	Compound Amount Factor F ⟶ A	Present Worth Factor P ⟶ A	n
1	1.1200	0.8929	1.00000	1.12000	1.000	0.893	1
2	1.2544	0.7972	0.47170	0.59170	2.120	1.690	2
3	1.4049	0.7118	0.29635	0.41635	3.374	2.402	3
4	1.5735	0.6355	0.20923	0.32923	4.779	3.037	4
5	1.7623	0.5674	0.15741	0.27741	6.353	3.605	5
6	1.9738	0.5066	0.12323	0.24323	8.115	4.111	6
7	2.2107	0.4523	0.09912	0.21912	10.089	4.564	7
8	2.4760	0.4039	0.08130	0.20130	12.300	4.968	8
9	2.7731	0.3606	0.06768	0.18768	14.776	5.328	9
10	3.1058	0.3220	0.05698	0.17698	17.549	5.650	10
11	3.4785	0.2875	0.04842	0.16842	20.655	5.938	11
12	3.8960	0.2567	0.04144	0.16144	24.133	6.194	12
13	4.3635	0.2292	0.03568	0.15568	28.029	6.424	13
14	4.8871	0.2046	0.03087	0.15087	32.393	6.628	14
15	5.4736	0.1827	0.02682	0.14682	37.280	6.811	15
16	6.1304	0.1631	0.02339	0.14339	42.753	6.974	16
17	6.8660	0.1456	0.02046	0.14046	48.884	7.120	17
18	7.6900	0.1300	0.01794	0.13794	55.750	7.250	18
19	8.6128	0.1161	0.01576	0.13576	63.440	7.366	19
20	9.6463	0.1037	0.01388	0.13388	72.052	7.469	20
21	10.8038	0.0926	0.01224	0.13224	81.699	7.562	21
22	12.1003	0.0826	0.01081	0.13081	92.503	7.645	22
23	13.5523	0.0738	0.00956	0.12956	104.603	7.718	23
24	15.1786	0.0659	0.00846	0.12846	118.155	7.784	24
25	17.0001	0.0588	0.00750	0.12750	133.334	7.843	25
26	19.0401	0.0525	0.00665	0.12665	150.334	7.896	26
27	21.3249	0.0469	0.00590	0.12590	169.374	7.943	27
28	23.8839	0.0419	0.00524	0.12524	190.699	7.984	28
29	26.7499	0.0374	0.00466	0.12466	214.583	8.022	29
30	29.9599	0.0334	0.00414	0.12414	241.333	8.055	30
31	33.5551	0.0298	0.00369	0.12369	271.292	8.085	31
32	37.5817	0.0266	0.00328	0.12328	304.847	8.112	32
33	42.0915	0.0238	0.00292	0.12292	342.429	8.135	33
34	47.1425	0.0212	0.00260	0.12260	384.520	8.157	34
35	52.7996	0.0189	0.00232	0.12232	431.663	8.176	35
40	93.0510	0.0107	0.00130	0.12130	767.091	8.244	40
45	163.9876	0.0061	0.00074	0.12074	1,358.230	8.283	45
50	289.0022	0.0035	0.00042	0.12042	2,400.018	8.305	50
∞				0.12000		8.333	∞

Source: WAEC (1992)

Table A12: 15% Compound Interest Factors

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TABLE A-12 15% Compound Interest Factors

	SINGLE PAYMENT		UNIFORM SERIES				
n	Compound Amount Factor F ⟶ P	Present Worth Factor P ⟶ F	Sinking Fund Factor A ⟶ F	Capital Recovery Factor A ⟶ P	Compound Amount Factor F ⟶ A	Present Worth Factor P ⟶ A	n
1	1.1500	0.8696	1.00000	1.15000	1.000	0.870	1
2	1.3225	0.7561	0.46512	0.61512	2.150	1.626	2
3	1.5209	0.6575	0.28798	0.43798	3.472	2.283	3
4	1.7490	0.5718	0.20026	0.35027	4.993	2.855	4
5	2.0114	0.4972	0.14822	0.29832	6.742	3.352	5
6	2.3131	0.4323	0.11424	0.26424	8.754	3.784	6
7	2.6600	0.3759	0.09036	0.24036	11.067	4.160	7
8	3.0590	0.3269	0.07285	0.22285	13.727	4.487	8
9	3.5179	0.2843	0.05957	0.20957	16.786	4.772	9
10	4.0456	0.2472	0.04925	0.19925	20.304	5.019	10
11	4.6524	0.2149	0.04107	0.19107	24.349	5.234	11
12	5.3503	0.1869	0.03448	0.18448	29.002	5.421	12
13	6.1528	0.1625	0.02911	0.17911	34.352	5.583	13
14	7.0757	0.1413	0.02469	0.17469	40.505	5.724	14
15	8.1371	0.1229	0.02102	0.17102	47.580	5.847	15
16	9.3576	0.1069	0.01795	0.16795	55.717	5.954	16
17	10.7613	0.0929	0.01537	0.16537	65.075	6.047	17
18	12.3755	0.0808	0.01319	0.16319	75.836	6.128	18
19	14.2318	0.0703	0.01134	0.16134	88.212	6.198	19
20	16.3665	0.0611	0.00976	0.15976	102.444	6.259	20
21	18.8215	0.0531	0.00842	0.15842	118.810	6.312	21
22	21.6447	0.0462	0.00727	0.15727	137.632	6.359	22
23	24.8915	0.0402	0.00628	0.15628	159.276	6.399	23
24	28.6252	0.0349	0.00543	0.15543	184.168	6.434	24
25	32.9190	0.0304	0.00470	0.15470	212.793	6.464	25
26	37.8568	0.0264	0.00407	0.15407	245.712	6.491	26
27	43.5353	0.0230	0.00353	0.15353	283.569	6.514	27
28	50.0656	0.0200	0.00306	0.15306	327.104	6.534	28
29	57.5755	0.0174	0.00265	0.15265	377.170	6.551	29
30	66.2118	0.0151	0.00230	0.15230	434.745	6.566	30
31	76.1435	0.0131	0.00200	0.15200	500.957	6.579	31
32	87.5651	0.0114	0.00173	0.15173	577.100	6.591	32
33	100.6998	0.0099	0.00150	0.15150	664.666	6.600	33
34	115.8048	0.0086	0.00131	0.15131	765.365	6.609	34
35	133.1755	0.0075	0.00113	0.15113	881.170	6.617	35
40	267.8635	0.0037	0.00056	0.15056	1,779.090	6.642	40
45	538.7693	0.0019	0.00028	0.15028	3,585.128	6.654	45
50	1,083.6574	0.0009	0.00014	0.15014	7,217.716	6.661	50
∞				0.15000		6.667	∞

Source: WAEC (1992)

Table A13: Present Value of =N=1 payable (or receivable) at the end of any period 1 to 10, discounted at interest rates from 9% to 20% per period

Table App1: Present Value of £1

Present Value of £1 payable (or receivable) at the end of any period 1 to 10, discounted at in

per period.

Period	9% (£)	10% (£)	12% (£)	20% (£)
1	0.917	0.909	0.893	0.833
2	0.842	0.826	0.797	0.694
3	0.772	0.751	0.712	0.579
4	0.708	0.683	0.636	0.482
5	0.65	0.621	0.567	0.402
6	0.596	0.564	0.507	0.335
7	0.547	0.513	0.452	0.279
8	0.502	0.467	0.404	0.233
9	0.46	0.424	0.361	0.194
10	0.422	0.386	0.322	0.162

Source: Shittu (2022)