

EiABC
PROGRAM: CONSTRUCTION TECHNOLOGY AND MANAGEMENT
COURSE: PRINCIPLES OF CONSTRUCTION MANAGEMENT(COTM 2171)
Responsible chair: chair of construction management

Course Outline

1 Background to the construction industry

- 1.1 Characteristics of the construction industry
- 1.2 The development of construction in Ethiopia
- 1.3 Importance of the construction industry to the nation's economy
- 1.4 Major stakeholders of construction and their responsibilities and contributions

2 General Management basics and organization

- 2.1 Definitions and development of management
- 2.2 Basic functions of management
- 2.3 Level and roles of management
- 2.4 Organization management

3 Construction project management

3.1 Project and project management

- 3.1.1 Introduction and definitions
- 3.1.2 Project (product) life cycles
- 3.1.3 Project management processes

3.2 Introduction to knowledge areas of project management

- 3.2.1 project scope management
- 3.2.2 project time management
- 3.2.3 project cost management
- 3.2.4 project quality management
- 3.2.5 project resource management
- 3.2.6 project communications management
- 3.2.7 project risk management
- 3.2.8 project procurement management
- 3.2.9 project safety management
- 3.2.10 project environmental management
- 3.2.11 project financial management
- 3.2.12 project claim management

References:

- 1. A guide to project management body of knowledge (Project Management Institute)
- 2. Any materials related to the topics

INTRODUCTION

The construction industry is an enormously important part of any economy. Economic growth depends on the physical infrastructure that is delivered by the construction industry and its key participants. Construction, responsible for creating, defining and maintaining the built environment within which most other social and economic activities take place, is by far the most important way in which societies create new value. It provides a society with delivery mechanisms for many aspects of its needs such as economic, social, political, environmental, public sector reform. The industry's products are essential to mankind's physical and social day-to-day existence.

With many other industries such as manufacturing (steel industry), material industry, etc intertwined with the works being undertaken as construction, the sector is said to be one of the major sectors on which many of society's (especially in developing nations) progress is based on.

CHARACTERISTICS OF THE CONSTRUCTION INDUSTRY

Generally the construction industry is labeled as a 'conservative industry' which adopts new technologies and practices at a slower rate as compared to other industries such as the IT, manufacturing and the automotive and invests very little in capital, research & development and training (Egan 1998). Moreover, construction is overwhelmingly known for following a fragmented and sequential project delivery system whereby projects are incepted by clients, designed by consultants and implemented by contractors mainly in a very fragmented manner.

The strategy of the conventional processes of sequential project delivery system is meant to minimize risks and changes through thorough descriptions of specifications and contracts. This sequential separate system of project delivery, however, is believed to be an effective barrier to using the skills and knowledge of contractors and suppliers in design and planning of the projects (Latham 1994).

The conventional procurement system, which assumes that clients benefit from choosing a new set of project team selected competitively for every project they engage on, is also believed to be a major obstacle for the advancement of the industry. This aggressive separate procurement system inhibits learning, innovation and development of skill. It prevents parties from developing a synergy on past relationships and also leads to the adversary and confrontational supply chain relation that the industry is known for as the fierce competition on price forces parties to lower their quoting to win the project with a believe that they will compromise through change requests-hence destabilizing the industry (Egan 1998).

'UNIQUE' CHARACTERISTICS OF CONSTRUCTION AND THEIR EFFECTS IN THE INDUSTRY

Aside from major characteristics that have defining effects on its functioning, the construction industry is espoused to have a number of characteristics that sets it as 'unique' from most other industries. These characteristics embrace a number of political, social and economic aspects and are believed to have a telling effect in the way the industry is functioning; including the problems mentioned above.

Nature of Production

In most cases, except for the minor cases of pre-fabricated constructions, the place of production of construction has to be necessarily the place where the product is going to be used. Thus the working place is changing regularly with workers constantly moving from one site to another, cooperating with different partners and in different chains. Besides because the site of production is the site of product which has to be built yet, work in construction industry is mostly exposed to inclement weather, and therefore, to seasonal cycles and disruption.

Because the character of work is of temporary duration, labor contracts are very often of a fixed term nature. Hence, insecurity of employment and earnings is significantly higher than in other industries. Due to instability of the production process, its exposition to weather, and variable working environment, the incidence of accidents is significantly higher than in most other industry (perhaps only less than mining).

For these reasons of peculiarity regarding the sector's production process including work organization (and others) there are some peculiarities in the construction industry's labor relations, with very often lower wages, particular vocational training systems, social funds to compensate disadvantages caused by health and safety risks, disruption of earnings, and fluctuation with negative effects on earnings, vacation, and pensions.

Nature of the product

The outputs of construction are generally large, heavy, durable, expensive, heterogeneous, and immobile in addition to being required over a wide geographical area. Due to the identity of location of production and location of products, with products immobile, the construction market is mostly restricted to be local. Thus the construction market is dominated by small enterprises that perfectly meet the low-size scale of most sites or the specialization of trade respectively and the geographic market.

Demand for the industry's products

Unlike most consumer products that are readily produced in bulk, the demand for the product of the construction industry is generally only produced upon the initiation of, and to the requirements of the clients. With the exception of the sometimes-speculative building, clients must first define their requirements in terms of what product that they want and only then can the construction industry build it.

Moreover, the level and type of demand cannot be controlled, manipulated or easily created by the industry itself. Hence unlike most industries where a considerable proportion of effective demand for their products is created and managed by the producers themselves through extensive marketing and application of new technologies, demand for construction products is mainly secondary or derive. Hence the demand is determined by the demand and output of other goods and services such as investment goods for which the ultimate use is either as a means to further production an addition to

or improvement of the infrastructure of the economy a social investment or an investment good for direct enjoyment, which it creates or helps create.

The implication of this is that it is much more difficult for the construction industry to create or manipulate demand for its products since such factors are not under the control of the industry. However, the inability of the industry to manipulate demand could also be partly attributed to the overall structure of the industry, as will be discussed below.

The structure of the industry

The product and production characteristics stated above largely determine the structure of the industry including the proliferation of many small firms, each forming temporary alliances upon project basis for the duration of the project. Further, the construction industry is highly fragmented with the planning, design and procurement of a building being separated from its construction process.

The industry is characterized by high levels of uncertainty. The demand is so variable and the environment so competitive for work that creates low levels of profitability. Researchers (for example, Flanagan et al. 1998) argue that profits in construction will remain low for as long as construction is seen as a low-technology industry and while many firms are prepared to win work with low-profit margins.

The construction industry is large, its activities are fragmented and include a wide range of types and sizes of construction works to enable it meet a variety of client needs. Generally, the vast majority of works are small and although in value terms, each is insignificant, combined, they represent a large part of the construction industry's total output. Time lags in the construction process tend to be long and variable and there are large fluctuations in the demand for construction over time. Because of this, it is only logical that the industry has to respond to the character and pattern of demand as it arises.

Because of all the above reasons and 'peculiarities', it is claimed that it is difficult for construction industry to adopt manufacturing industry-style supply chain management and delivery of projects Cartlidge (2002). On the other hand, the construction industry which is typically associated with late delivery, over budget, low profitability, poor returns and slow up take of new technology and management philosophies is challenged to discontinue disguising its inefficiency behind the idea of the industry being so different from others (Flanagan et al. 1998; Egan 1998). It is suggested that as the construction industry evolves, it can and will start to learn and benchmark ideas from outside industries, such as manufacturing and the IT (Egan 1998).

The Workforce

Although some inputs can be manufactured off-site, construction activities take place on site. This also means that inclement weather could or does affect the progress of the work on site. The industry is, by its very nature, an overwhelmingly domestic and labour-intensive industry despite the advancement in modern technologies. This situation is perpetuated by the fact that because most firms are small, there is no single organization or 'champion' to spearhead change in the industry particularly as it relates to technology.

Typically, 90% of construction workers in both developed and developing countries are employed in micro firms with fewer than ten people and small and medium sized firms constitute 97% of all construction firms globally (CSIR, 2003). It therefore follows that the skills and commitment and effective organization of the work force are crucial in determining whether or not the industry can produce a high quality of output at a fair price. It has also become apparent that there is need to change working patterns and challenge existing attitudes, which calls for a need for effective communication, education, training, participation and involvement (Flanagan *et al* 1998).

The common working practices, namely self-employment and labor-only sub-contracting, differentiates the construction industry from most other industries. These practices also contribute heavily to the many disadvantages for which the construction industry has been criticized including, the temporary nature of the work, poor site safety record, lower wages and lower social status of its labour force, inadequacy of training and consequent skills shortage.

CONSTRUCTION IN ETHIOPIA AND MAJOR SECTORS OF CONSTRUCTION WORKS

Construction and the ability to build things has transcend from the most ancient human skills of the Primary age to the modern ages of Industrialization and Information. During the whole of Primary age, the construction industry has largely related to talents of human beings on how to construct shelters and small roads and river improvements. Generally speaking, the focus during this age is largely on fulfilling humans' basic needs and major figurative and monumental ones.

As the number of humans' enlarge and their demands become more, a need to fulfill such demands amass and in short period of time pressed human beings to search for alternatives in order to live peacefully for their co-existence. This leads to creating appropriate technology that develop progressively in line with increasing productivity. This brought the development of society into the Industrialization age where mass production for assembly is becoming possible. This brought different approaches to construction methods and their completion times.

This period has mainly created conscious way of technology improvements for first mass production followed by quality enhancement and productivity issues. Subsequently, the concept of competition such that time, quality and cost values were starting to govern. The development of technology and the concepts of competitions opened a considerable role for management functions such as planning, implementing and controlling cycles.

The information age which made most cumbersome mathematical calculations simple and that brought and revealed many more complex factors involved in construction processes enhanced the way how construction activities need to be managed. As a result, Management functions have enlarged and become more important for the construction industry competitiveness and development.

Construction works in Ethiopia can be dated back to the Shaba era during which time the famous queen built her palaces. Ranges of glamorous constructions, such as the Axum Oblisques, the Lalibela Rock Hewn Churches, the Gondar Palaces, the Harar Walls, the Sof Umar caves, etc have been curved and erected in a widely spaced times since then. However, the Ethiopian construction industry has only been organized in modern ways during the Imperial Majesty's era. With the establishment of the then Ministry of Works, and later such authorities as Imperial Highway Authority, Building and Transport Construction and Design Authority (BaTCoDA), the industry took shape and establishment of government divisions to promote progress & developments. Since then, various readjustments and proclamations have been made to suite the authorities to the needs and ideologies of the governments in power. Under the tutelage of the current government, series of proclamations have been made to re-arrange and re-establish various sections of the industry.

Under the current setup, the Ministry of Works and Urban Development is mandated to look after the various issues and aspects surrounding construction with other ministries and authorities such as the Ministry of Water Resources, Ministry of Infrastructure, also playing a prominent role in the industry.

Construction works can generally be classified in to two: *The building* sector overlooks many of the building and related works while the *civil works* (infrastructure), sector looks over other usually huge and machine intensive works associated to infrastructure delivery such as highways or power supply. In Ethiopian context, such works are usually further divided as the building sector works, road (transportations) sector works, civil works in the power and water sector developments and to some extent the communication sector programmes.

IMPORTANCE OF THE CONSTRUCTION INDUSTRY TO THE NATION'S ECONOMY

The construction industry has a significant multiplier effect on a given economy. There is a relationship between output, employment, income and demand. It is generally argued that, due to its multiplier effect, for every job in the construction two other jobs will be created in other sectors as a result. In developing countries like ours, the construction industry plays significant roles not only in defining the built environment where other socio-economic endeavors take place but also by playing a considerable role in triggering economic development and providing a huge amount of business and job opportunity to citizens.

The industry provides significant amounts of fixed investment, contributes considerably to the national output and is a major source of employment; directly and indirectly by its multiplier effect. Studies show that in most countries construction constitutes more than half of capital investment, contributes up to 10% of GDP and employs more than one hundred million people globally which accounts for almost 28% of all industrial employment (CSIR 2003; Winch 2002). For developing nations like our, these figures are believed to be much higher higher.

Table 1: 1 Contribution of construction towards overall economy in selected countries (1980 market value)

Countries	Value added to GDP	Share of Gross Fixed Capital Formation
France	5	56
UK	6	48
USA	4	55
Kenya	5	48
Ethiopia	?	?

Certain actions, particularly government ones, such as an increase in the interest rate or decrease in supply of credit affects not only the demand on construction industry but also firms in the industry. Any change in the level of construction output will also affect employment and hence incomes, demand and ultimately outputs of other sectors of the economy.

Consequently, the construction industry is often used as a regulator of the general economy. It has proved a good instrument for transmitting short-term deflation through the economy without creating widespread political upheaval, economic disruption or closure of productivity capacity.

Under conventional “Keynesian” economic theory, when the economy is in a recess, as output and employment falls, the government would increase spending to stimulate economic activity, and when there is a boom, government would reduce its spending. In the same way, low income, low investment and low levels of productive employment feed into one another. Thus, targets for construction output and employment should be integrated within macro-economic planning.

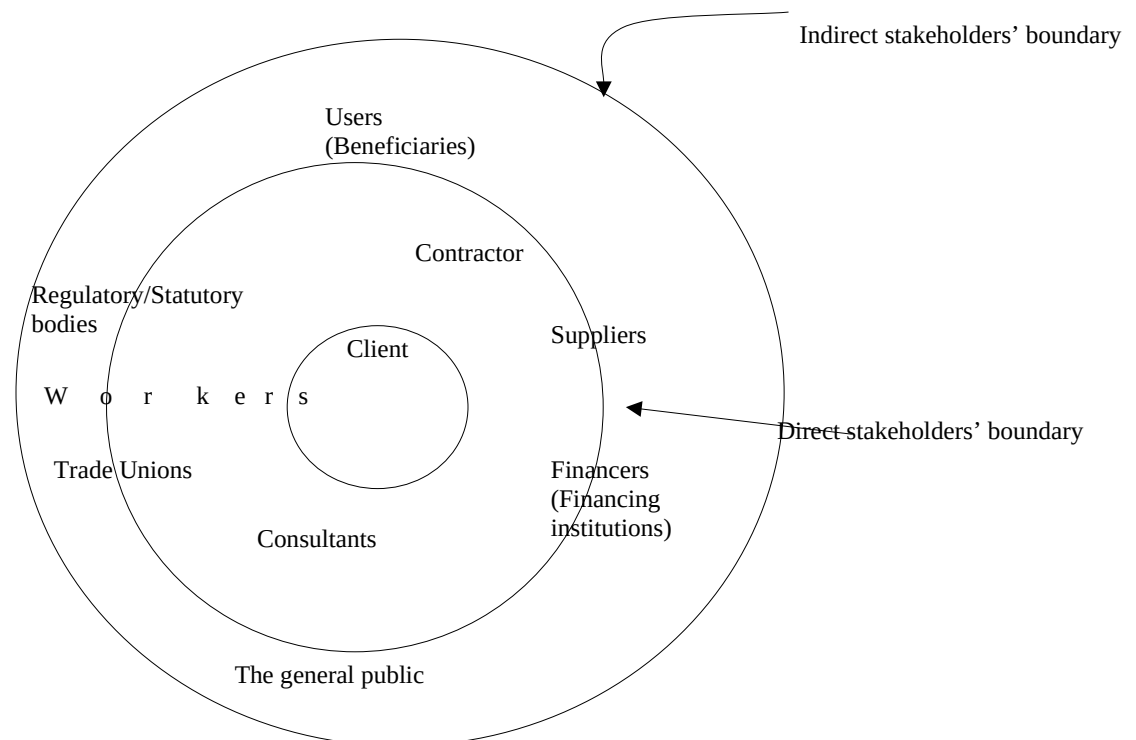
Government’s influence coupled with the investment nature of the construction industry’s product means that demand tends to fluctuate particularly according to the state of the economy and the social, economic policies of the government, with consequent effects on the industry. Change in the construction industry is constant and is influenced by many factors including interest rates, business uncertainty, and government policy, world events, training and changing expectations of clients. Typically, variations in construction output have little physical short-term effects particularly because of the durability of most construction products. Time lags in the construction process tend to be long and variable and there are large fluctuations in the demand for construction over time. This implies that the amount spent on construction can as a result vary quite sharply from year to year without significantly affecting the state of the built environment.

It is therefore, for both economic and administrative reasons, that the reductions and increases in government spending are often concentrated on construction projects. And it is due to this monumental importance that government gives a considerable emphasis in shaping the practice of construction. As part of shaping and defining standard and safe practice of construction, government sets up laws, regulations and standards along with the responsible bodies to see after these practices.

MAJOR PARTIES/STAKEHOLDERS OF CONSTRUCTION AND THEIR RESPONSIBILITIES AND CONTRIBUTIONS

By definition, stakeholders are individuals or groups who have a vested interest in a given issue. In the construction context then, they are parties who will be interested in projects undertaken or products delivered by the industry. Classified as positive or negative depending on their interest and direct or indirect (internal or external) depending on their involvement on the project, stakeholders are parties who could have a telling effect on the success or failure of the project.

In the construction arena, put simply the major stakeholders of the construction industry are the contractors who implement the projects, the consultants who design and supervise the works, the client who finance the projects and the regulators who regulate how the industry and its actions functions. Left in these quartets who usually involve in the actual execution of the projects are the user who actually use the final product of the project.



- **Client:** are the parties (public or private) under whose tutelage the project is executed
 - Comes up with the investment needs such as project idea, land, capital etc.
 - Usually provides the infrastructure needed
 - Takes care of some of the legal constraints & permits
 - Leases the project's execution

In public projects, besides the client, government institutions (other than the direct client body) may also take interest in the project. In Ethiopian context, the major public clients in the construction industry include, the Integrated Urban Housing Development

Programme Office (IUHDPO) under the Ministry of Works and Urban Development, the Ethiopian Road Authority (ERA), the Ethiopian Electric Power Corporation (EEPCO), the Ministry of Water Resources (MoWR), the Defense Force, Ministry of Health, Ministry of Education, etc and their regional subsidiaries/equivalents. Besides, the private sector also takes a huge stake as a client, particularly in the housing sector.

- **Consultants:** are professional bodies who design the project
 - Change the clients project idea into economic and constructable artifact
 - Make sure that design satisfies requirements
 - [Usually] prepare BoQ and contract documents
 - If assigned to supervise:
 - ✓ Look after proper execution of project
 - ✓ Certify payment certificates
 - ✓ Issue provisional and final acceptance certificate
- **Contactors:** are the parties that change the drawings and specification made by the consultants into a physical structure
 - Prepares a bid document
 - Provides the resources needed to execute the project
 - Executes the project according to plan
 - Monitors project execution
 - Rectifies defects
- **Statutory bodies:** are government bodies that looks after the project's compliance with the general public's interest
 - Prepare a general development scheme and make sure that the project satisfies that.
 - Look after the safety, legal, commercial etc issues associated with the project
 - Look into the environmental, cultural, social etc effect that the project induces,

In Ethiopia, the major statutory bodies involved in the construction industry includes: **Municipalities:** Bodies who are given the mandate to look after urban housing construction and its associated legalities; the **Ethiopian Road Authority:** Besides being a major client of the road sector by itself, the ERA is the party mandated to look after the road sector construction works; the **Ministry of Water Resources;** is the party mandated to overlook water sector development programs; the **Ministry of Works and Urban Development,** the party mandated to regulate and promulgate bylaws, codes, standards, etc meant to promote efficiency, transparency, accountability as well as growth in the industry; Etc. In addition to the above (mainly national bodies), the regional regulating bodies also have a huge stake in shaping how the industry is performing in each state.

- **Suppliers:** are parties that supply the varies materials, equipments and services needed for the project
- **Financers (Financial institutions):** are donating or loaning agencies or institutions like banks, insurances, pension agencies etc who could provide loan services for the project

- **Works in the industry:** are professionals, occupational or unskilled laborers who earn their living from working in the industry or its supply chain.
- **Trade Unions:** Though not much visible in Ethiopian context, are unions of the working class that look after unfair treatment of workers (like payment issues, firing issues) as well as issues related to occupational health and safety.
- **Project product users:** are parties who may be using the end product of the project
- **The general public:** are communities of the locality, the general society of a country or even the globe who may have a vested interest in the project.
- **Other sectors:** are sectors which could have interest in the process or product on the construction project

Major challenges of the industry

Perhaps related to its inefficiencies as manifested by late delivery, over budget, low profitability, poor returns and slow up take of new technology and management philosophies, the global construction's contribution towards the global economy is diminishing (particularly in the developed nations). It is often being replaced by the service industry, which is quite known for its continuous improvement and customer focus, especially in developed nations which, more or less, have already implemented a well functioning infrastructural network. Despite its relative success in the past few years, the construction industry in Ethiopia has also got multifaceted problems and challenges. Some of major ones are:

➤ Lack of capable local firms.

Considerable proportions of the above programs were/are being implemented by international companies (contractors, suppliers, consultants etc). This creates a huge problem/challenge for the local firms to build their capacity. Besides, it results in lose in business and job opportunities, siphoning of hard currency, etc

The major reason why local firms don't take large proportion of the industry's share is lack of capacity. As things stand, the majority of the local firms don't satisfy the screening requirements the international financing bodies demand. The major evaluation criteria set by these bodies are:

- Average/total value of work over the past (5 years)
- Experience in work of similar nature and size in the past (five years), details of similar work underway (at least 70% complete), (all as a prime contractor) references
- Major items of Contractor's Equipment proposed for carrying out the Works
- Qualifications and experience of key personnel proposed for administration and execution of the Contract;
- Financial reports for the last five years and evidence of access to financial resources to meet the qualification requirements, etc

Major stakeholders (contractors & consultants) lack capital (equipment and machineries), financial, institutional (managerial, experience, reputation, etc), human (competency and capability), etc resources to satisfy the above requirements. Besides, financial and loaning system and other industries (which supply the construction industry such as the material and manufacturing industry) are not well developed to supply construction with what it needs and support the local firms.

➤ ***Poor project delivery success rate***

Most of the projects delivered in recent years in the country have failed under the conventional project success criteria of being delivered on *time*, on *budget* and to the *standard and quality* required. These results in huge impact on the country's already constrained resource as it means loss of extra resource to initially implement the projects, necessity to maintain infrastructure before their due period, etc.

Various reasons can be cited for these. But the most prominent reason has to be the industry's inability to embrace *professionalism*. As things stand, projects are incepted, planned and executed outside the realms of professional project management principles and practices. This is bound to result in inefficiencies and ineffectiveness.

➤ ***Others***

There are of course many other causes which render the industry inefficient. Among these: very weak industry stakeholders link (eg. Industry Vs training institutions, designers vs implementers, etc), not supportive and up to scratch laws, codes procedures and standards, bureaucratic working systems (not only confound to the construction industry but related to the whole supply chain), various problems in procuring and contract administration processes, non motivated, non committed and incapable (especially when it comes to decision making) work force, almost non visible professional associations to set standards and implement professionalism, etc

GENERAL MANAGEMENT BASICS AND ORGANIZATION MANAGEMENT

The discipline of project management traces its root heavily from the management principles, theories and practices that have been evolving through the years. Over the years, many crucial revelations and understandings were shaping mankind's understanding of reality and best way of management. The section below discusses the major evolutions in management and its current state.

THE DEVELOPMENT OF MANAGEMENT

THE EVOLUTION FROM PRE-INDUSTRIAL ERA GENERAL MANAGEMENT TO CONSTRUCTION PROJECT MANAGEMENT AND THROUGH TO RECENT DEVELOPMENTS OF TQM, VM, CE & BPR

General Management is a broad area dealing with wider aspects of managing an ongoing organization and it covers the following among other topics:

- | | |
|--|---|
| ❖ Property Management | ❖ Stakeholders (Relationships) Management |
| ❖ Production & Distribution Management | ❖ Process / Result Management |
| ❖ Organization Management | ❖ Information Management |
| ❖ Resources Management | ❖ Research & Development (Knowledge) |
| ❖ Project Management | ❖ Performance Management, and |
| ❖ Strategic Management | ❖ Network Management |

These aspects have developed over centuries conceptually and in the management Practice. In its wider sense, management is required for getting the task done. That is; Management is the process of administering and coordinating resources effectively and efficiently and in an effort to achieve the goals of the organization (Pamela, et al; 1995). Efficiency and Effectiveness of management depends very much on how well the available resources are utilized to accomplish the intended objective.

With advancing technological and changing human behavioral aspects, management is increasingly becoming more complex and requires considerable training, practical experience and updating on the latest information of developments in the field. Like other disciplines, management thoughts have been enriched by many contributors of earlier practitioners in the field. Such contributions are developed to form the **Management Theory and Its Development**. Management theories the world over has both theoretical and applied contributors. These contributions can be classified as follows;

- | | |
|---------------------------------|----------------------------------|
| 1. Early contributions | 5. Quantitative contributions |
| 2. Industrial era contributions | 6. Systems Perspectives |
| 3. Classical contributions | 7. Contingency Perspectives, and |
| 4. Behavioral contributions | 8. Recent Contributions |

Early contributions: Most management thinkers in the 18th century classify management as applicable to only business or industry related discipline. This indicates that the management thought to the construction industry has been considered long ago. But historical evidences show that people were more concerned with the management of organizations such as the state, church, military, tribes, household, etc. These include:

- record keeping in 5000 BC,
- importance of planning, organizing, and controlling in 4000 BC,
- universality of management by 2000 BC,
- specialization in 350 BC,
- staff organization in military campaign in 330 BC,
- traits of a leader and/or a manager in 900 and 1100 AD, etc.

Industrial era contributions: The movement of manufacturing to a factory system during the mid 1700's had significant contributions to management theories. This era is customarily called industrial revolution era. In this era three major contributions can be identified, these are; *Human Resources Management, Scientific Management and Importance & initiatives for Management Training.*

1. Human Resources Management: **Robert Owen** (1771-1858), A successful factory manager in UK advocated improved management in human resources would result in higher returns of investments than in machinery and equipment. He attempted *to limit the working hours, using a silent monitor to encourage productivity, and to establish villages of cooperation* – Start and recognition of Workers' Association.
2. Scientific Management: **Charles Babbage** (1792-1871), Who was an early pioneer in areas that we now call as scientific management. He produced the first calculator he called it as the difference machine and a rudimentary computer he called it analytical machine. Besides, Babbage published his views on management and manufacturing processes including the concept of division of labor as a necessary aspect for developed economic systems. He also proposed observational procedures for studying manufacturing operations. Babbage believed that management and employee interests were closely linked to each other.
3. Management Training: **Andrew Ure** and **Charles Duprin** believed in management training that they educate managers of many factories for offsetting factory systems problems.

Classical contributions: The classical contributions towards the management thoughts includes two general features, these are *Administrative theories*, and *Developed Scientific Management concepts*. The two major contributions are best represented by the work of Henri Fayol and Fredric W. Taylor.

Henri Fayol (1841-1925) is known for the first general administrative theory developer of management. The basis of Fayol's theory was much depends on the industrial undertakings consisted of six separate activities or functions;

- **technical (production, adaptation)**
- **commercial (exchange)**

- financial (search for & optimal use)
- accounting (stocktaking, balance sheets)
- security (protection → property & persons), and
- managerial (planning, organizing, command, coordination, control)

Fayol concentrated on the management theory and developed the first general theory of management with the identification of fourteen basic principles:

- Division of work or labor,
- Authority and Responsibility,
- Discipline,
- Unity of Command,
- Unity of Direction,
- Subordination of individual interest to the general interest,
- Remuneration,
- Centralization,
- Scalar chain or line of authority,
- Order,
- Equity,
- Stability of tenure of personnel,
- Initiative, and
- Esprit De Corps or Union is Strength.

Frederick W. Taylor (1856 - 1915) is credited for the development of scientific management and outlined four principles:

1. Develop a science for each element of work, replacing the old rule of thumb,
2. Scientifically select and then train, teach and develop the workers,
3. Cooperate with the workers so as to insure all the work to be carried out in accordance with the principles of the science that was developed, and
4. provide equal division of work and responsibility to the management and the workers.

He developed five basic features of scientific management as well. These are;

1. Organizational and technical improvements
2. Provision of planning department
3. Use of experienced foremen
4. Time study to determine the rate at which a job should be done, and
5. An incentive wage system.

Classical contributions are also well known for its bureaucratic Management in addition to Administrative Management. Prominent contributor in this field was Max Weber.

Behavioral contributions: The behavioral contributions in management thought essentially base their theory on human behavior which is a complex subject but as the most vital aspect of management. The behaviorist believes that those involved in the organization are the prime determinants of the organizational and managerial effectiveness. The great diversity of the behavioral contributions makes it impossible to discuss all of its contributors. But for the purpose of this part two behaviorist are dealt:

Abraham H. Maslow (1908-1970) theorized that people are driven by several needs, not just one and developed a hierarchy of human needs. These are:

- Physical and physiological needs,
- Safety and security needs,
- Love or social needs,
- Ego or status needs, and
- Self actualization, realizations & fulfillment.

Physical needs are related to food, clothing and shelter. Safety needs include insurance, job security, retirement benefits, etc. Social needs include the need to express themselves to associate with others, etc. Ego needs involve the provision of status in the job. Self actualization can be expressed by a phrase “what a man can be he must be.”

Douglas McGregor (1906-1964) developed the two alternative management views of subordinates; Theory X and Theory Y. Theory X managers believe that their subordinates are uninspired workers who seek to avoid responsibility and work assignment and suggested that supervision and evaluation is the key for management functions. On the other hand, Theory Y managers believe that all subordinates view work as rewarding if given the chance by their superiors and implied that improved communications and greater employee participation in decisions would be most desirable for the success of management.

Quantitative contributions: The quantitative contributions consists major branches in decision theory and management science. Although the diversity of the branches makes precise definitions difficult, the contributions are generally characterized by attempts to systematize the decision making process using mathematics, statistics and other quantitative techniques. This use of mathematical models and quantitative techniques to solve managerial problems is often called operational research or management science. The Quantitative approach has four characteristics; Decision – Making focus; Measurable Criteria; Quantitative Model and Use of Computers.

Systems Perspectives: As suggested in the previous section, a **system** is a assemblage of interrelated parts that work together by way of some driving process Systems are often visualized or **modeled** as *component blocks* that have *connections* drawn between them. Most systems share the same *common characteristics*. These common characteristics include the following:

1. Systems have a **structure** that is defined by its parts and processes.
2. Systems are *generalizations* of *reality*.
3. Systems tend to **function** in the same way. This involves the **inputs** and **outputs** of *material* (*energy* and/or *matter*) that is then processed causing it to change in some way.
4. The various parts of a system have **functional** as well as **structural relationships** between each other.

5. The fact that functional relationships exist between the parts suggests the *flow* and *transfer* of some type of *energy* and/or *matter*.
6. Systems often exchange energy and/or matter beyond their defined boundary with the outside environment, and other systems, through various *input* and *output* processes.
7. Functional relationships can only occur because of the presence of a *driving force*.
8. The parts that make up a system show some degree of *integration* - in other words the parts work well together.

Within the **boundary** of a system we can find three kinds of *properties*:

Elements - are the kinds of parts (things or substances) that make up a system. These parts may be atoms or molecules, or larger bodies of matter like sand grains, rain drops, plants, animals, etc.

Attributes - are characteristics of the elements that may be perceived and measured. For example: quantity, size, color, volume, temperature, and mass.

Relationships - are the associations that occur between elements and attributes.

We can define the **state** of the system by determining the value of its *properties* (the **elements**, **attributes**, and/or **relationships**). Scientists have examined and *classified* many types of systems. Some of the classified types include:

- **Isolated System** - a system that has no interactions beyond its boundary layer. Many controlled laboratory experiments are this type of system.
- **Closed System** - is a system that transfers energy, but not matter, across its boundary to the surrounding environment. Our planet is often viewed as a closed system.
- **Open System** - is a system that transfers both matter and energy can cross its boundary to the surrounding environment. Most ecosystems are example of open systems.
- **Morphological System** - this is a system where we understand the **relationships** between **elements** and their **attributes** in a vague sense based only on measured features or correlations. In other words, we understand the form or morphology a system has based on the connections between its elements. We do not understand exactly how the processes work to transfer energy and/or matter through the connections between the elements.
- **Cascading System** - this is a system where we are primarily interested in the flow of energy and/or matter from one **element** to another and understand the processes that cause this movement. In a cascading system, we do not fully understand quantitative **relationships** that exist between elements related to the transfer of energy and/or matter.
- **Process-Response System** - this is a system that integrates the characteristics of both **morphological** and **cascading systems**. In a process-response system, we can model the processes involved in the movement, storage, and transformation of energy and/or matter between system elements and we fully understand how the form of the system in terms of measured features and correlations.
- **Control System** - a system that can be intelligently manipulated by the action of humans.

- **Ecosystem** - is a system that models relationships and interactions between the various biotic components making up a community or organisms and their surrounding physical environment.

Contingency Theory: Contingency theory often called situational management is an approach to management that emphasizes adjusting managerial actions and styles to the specific circumstances of the situation confronting the organization. Simply the management actions and styles should be dependent upon the circumstances of the situation confronting the manager. Environmental factors such as public opinion, employee and management attitudes might have impact on the decision making process.

Recent Contributions: A wide range of industrial, commercial and governmental organizations has adopted project management to handle their many and various projects. Unfortunately many projects are facing time and cost overruns due to environmental constraints and poor project management systems. This is true in the case of construction industries as well. Besides, the fact that construction projects:

- involve almost all industries and sectors in realizing their infra structural needs
- use wide variety of resources and their scarcity
- exhibit fierce competition nationally and globally
- decrease their profit margins to its lowest bottom

and the human, cultural and ecological aspects makes their management complex, risk undertaking, and working in an uncertain environment.

The Construction industry is the major and direct beneficiary of innovations from the field of General and Project Management. For effective and efficient accomplishment of construction projects and to increase their probability to success, project management concepts are undoubtedly necessary. The Professional Construction Management (PCM) itself is young and still is not widely assimilated into the construction industry. An attempt is made here, therefore, to review the salient features of Project Management concepts with focus on new ones that are relevant to the construction industry and identify how PCM can benefit from them.

A constant challenge faced by today's project management is change. On the one hand change represents growth, opportunity and development, and yet on the other hand change represents threat, disorientation, and upheaval. All management concepts would admit that there is no single prescription or formula possible for successes of projects. However, by applying the various new project management concepts, most, if not all, present problems can be solved.

These problems are further intensified with the size and complexity of construction projects. In such a context, traditional project management principles and tools alone are proving inadequate assistance to achieve and sustain improvements in the management of construction projects.

These facts, therefore, necessitate the creation and application of new project management principles. The present paper considers the following new project management principles: *Total quality management (TQM)*, *Management by projects (MBP)*, *Business process re-engineering (BPR)*, *Value engineering/ management (VE/ VM)*, and *Concurrent engineering (CE)*.

Total Quality Management (TQM): A typical definition for TQM is:

A cooperative form of doing business that relies on the talents and capabilities of labor and management, using teamwork, to continually improve quality, economy and productivity, to complete satisfaction and delight of the customer. (Sharad and Sulimani, 1994)

This definition embodies three basic ingredients of TQM: ***participative management and teamwork; continuous process improvement; and customer satisfaction and delight*** (Sharad and Taher, 1998). Arditi and Gunaydin also identified the factors that affect quality in each phase of the construction process as accepted elements of the TQM. TQM concepts first developed for the manufacturing industries in Japan and wide spread all over the world mainly due to its application resulted in increased productivity, decreased product cost, and improved product reliability. In the construction industry quality is defined as meeting the requirements of the designers, constructors, regulatory agencies and the owner. Quality can be characterized by meeting the requirements of:

- the *owner*, including functional adequacy, completion on time and within budget, and life cycle costs including operation and maintenance
- the *design professionals*, including provision of well defined scope of work, budget to assemble and use a qualified, trained and experienced staff, budget to obtain adequate field information prior to design, provisions for timely decisions by owner and design professionals, and contract to perform necessary work at a fair fee with adequate time allowances
- the *constructors*, including provision of contract plans, specification, and other documents prepared in sufficient detail to permit the constructor and prepare priced proposal, timely decisions by the owner and design professional on authorization and processing of change orders, fair and timely interpretation of contract requirements from field design and inspection staff, and contract for performance of work on a reasonable schedule which permits a reasonable profit, and
- the *regulatory agencies*, including public safety and health, environmental considerations, protection of public property, and conformance to applicable laws, regulations, codes and policies. (Arditi & Gunaydin, 1997)

These concepts are also applicable and very vital to the construction industry. This is because, attainment of acceptable levels of quality in the construction industry has long been a problem and considerable expenditures of time, money and resources, both human and material, are wasted each year because of inefficient or non-existent quality management procedures. Both approaches (Sharad & Sulimani and Arditi & Gunaydin) agree and are similar in principle. And

therefore, it is argued and believed that TQM application to the construction industry are necessary and useful to tackle most, if not all, quality problems.

Management by Projects (MBP): Management by projects is a way, an outlook, and an attitude cultivated to treat any trade of work, undertaking, scheme, assignment or a set of activities, as a project. What is immediately implied or called for by accepting a trade of work as a project is: *identified scope; required completion time; estimate of cost and other resources inclusive of manpower; economic quality performance; and review of the work done with follow-up of some kind* (Taher & Sharad, 1998).

MBP provided the basis to carry out a business like a project, with a systematized process of planning, executing and controlling. A project is unique in its character and has a definite beginning and end together with a completed product of an acceptable quality and economy. This is what essentially distinguishes Management by projects from general or corporate management. Professional Construction Management (PCM) is essentially the management of construction projects, which is analogous, if not synonymous, with MBP as applied to the construction industry. Planning and scheduling, cost estimating-budgeting-monitoring-forecasting, contract administration, quality control/assurance, progress measurement and reporting, and human aspects like teamwork are all as relevant to PCM as they are regular features of MBP methodology. MBP, therefore; provides the essential project orientation for managing construction, and advocates employing the project management tools and techniques.

Business process re-engineering (BPR): BPR is defined as:

An organizational improvement methodology that focuses on redesigning organizational processes 'from the ground up', using information technology to integrate work, increase consistency, and dramatically shorten process cycle times. (Mattinsly, 1994).

BPR advocates '**radical improvement**', rather than 'continuous improvement', of processes for better ultimate performance. Key features of BPR includes ***rapid thinking, creating new scenario, simplify processes, information technology to reintegrate works, fewer skilled employees, and flatter organization***. I strongly believe that though BPR is often criticized for its radical approach, it pays great dividends when successful, what matter is when and under what conditions it is necessary.

Obviously, It involves **risks, such as: investments in complex information system; potential damage to organizational culture, and reduced motivation of the few remaining employees**. However, it provides several benefit including **simpler and shorter processes, fewer but highly skilled employees, flatter and more efficient organization, and lower structural costs**.

According to Dey (1999) Construction, as a business process, can very well utilize business process re-engineering improvement techniques. Construction projects have been re-engineered from earlier times till now. This varies from an engagement of one party to design and build by the owner to the PCM approach to a stage where construction managers or project managers undertaking responsibility to develop an overall project plan and monitor its progress.

Besides, the traditional bar chart schedule was re-engineered into CPM and PERT with the application of computerized aids and its further re-engineering reached today's level of considering uncertainties in scheduling by the use of stochastic analysis. Therefore BPR is one of the newly realized and emerging concept of project management, though not entirely a new concept in practice, that is relevant to the construction industry. To effectively use BPR in the construction industry the following steps with the recognition of challenges and pitfalls together with the solutions is recommended:

Steps:

1. Process re-engineering including identification of processes; selection of key processes; selection of key areas of improvement; and deriving the re-engineered process.
2. Planning information systems in line with the process requirement; and
3. Applying advanced project management tools and techniques including project risk management.

Challenges / pitfalls:

1. Re-engineering of processes require drastic paradigm shifts which may take a considerable time for adaptation in the existing system;
2. New processes may require application of some new tools and techniques which may cause problems during adoption in the existing methods; and
3. Re-engineering processes demand the application of information technology (IT) tools, which may require additional capital investment.

Solutions:

Attitude changes, Appropriate training, and Cost benefit analysis to justify investment. (Dey, 1999)

Value Engineering / Management (VE / VM): Value Engineering is a systematic study of project requirements using a multi-disciplined team to identify and eliminate unnecessary costs and poor performance by using functions (Sievert, 1991). Analysis of functions is the foundation of value engineering using a project team approach. Value engineering provides an effective environment for the project team to cooperate, communicate, resist premature decision-making that can result in unnecessary costs, and an organized and expedient system for extracting information from owners and users to make effective project decisions.

Accordingly, Sievert developed a job plan approach to the project team for effective application of VE consisting of five phases: *Information, Creativity, Evaluation, Development and presentation, and Implementation*. And he suggested that VE can be applied during any phase of the project cycle. But he strongly emphasized that the greatest return on the value engineering investment can be expected when the value study is initiated during the planning and programming phase of a project, where the ability to influence costs is greatest. As a result, I agree with Sievert that, it is to the advantage of all parts in the construction industry, if project plans are starting with the right information after VE study is completed. This can be exemplified by the following illustration.

Oftentimes owners commit substantial funds and resources to a construction project prior to defining the specific need for the project, program requirements and cost management procedures. It is a risky business and the result could be cost and time overruns, quality control problems, changes, disputes or an end product that does not function as intended. Construction projects integrate the principles of multi-dimensional professions: business administration, engineering know-how, communication skills, and behavioral sciences.

It is of no value therefore, if the project result does not meet the customers' requirements regardless of its price. Besides, as change and modification are facts of management, plans must be made not only to provide us with the management of change, but also with the insurance that this constant change is used to our advantage (Mudge, 1989 in Sievert's article). This major advantage to us is the removal of unwanted and unnecessary factors from our business environment. Value engineering facilitates planning for a positive course of action to remove these factors, and bring in better results at total lower costs.

Concurrent Engineering (CE): Concurrent engineering is defined as:

A systematic approach to the integrated, concurrent design and their related processes, including manufacturing and support. This approach is intended to cause developers from the outset, to consider all elements of the product life-cycle from conception through disposal including quality, cost, schedule, and user requirements (Winner, 1988).

CE bases its concepts on the development of Partnership, Design-and-Construct, Build-Own-Operate-Transfer (BOOT), Design-Build-Finance-Operate (DBFO) and Management Contracting and Construction Management methods of Procurement. In achieving customer requirements and project objectives and effectiveness, CE founded its reliance on the principles given in table 1 (Love, Gunasekaran and Li, 1989). Gabriel, 1997 has also a similar approach to CE project management method that he called a lean project management. The lean management enables client interests to be represented without communication delays. Table 1 also presents Gabriel's

lean approach to project management to show their similarities to CE principles. CE is conceptually an effort to effectively integrate all aspects of product development, by performing simultaneously a variety of activities that used to be done sequentially.

The construction process has been heavily criticized for its fragmented approach towards the delivery of construction projects. This has affected project effectiveness in as much as traditional practices do not effectively encourage the integration, coordination and communication between participants. This inhibits the scope for creativity and innovation throughout the project cycle. CE has great potential in overcoming these problems and may significantly improve the way in which construction projects are realized, specifically in eliminating the procurement gap existed between design and construction. This gap contributed to major behavioral, cultural and organizational differences between project individuals and groups, and perhaps most of all, the communication process. Therefore, CE is expected to satisfy the need for procurement strategy that can effectively coordinate and integrate individuals and groups for construction projects leading to inter-organizational communication and team building to thrive and become a normal practice.

BASIC FUNCTIONS OF MANAGEMENT AND ROLES OF MANAGERS

FUNCTIONS OF MANAGEMENT

Functions of management can be described in four major elements. These are:

■ Planning

■ Organizing

■ Implementing, and

■ Monitoring.

These functions are seldom well established in the construction industries in Ethiopia. And each management levels are operating their construction activities not beyond the output with individual inborn gifts and social experience capabilities. However, it should not be over passed that wider application in the industry is in practice led to grow the management concept and application development nation wide.

PLANNING: Planning involves setting visions, missions and goals of organizations or projects or programs together with the activities to achieve them. All levels of managers develop goals that corresponds to the efforts of the top management overall goals and strategy. This requires operational plan aimed at administration and coordination of Stakeholders, Processes and Resources. Planning is beneficial in that it makes better coordination, focuses on forward thinking, creates participatory work environment and good for effective monitoring and feedback systems.

ORGANIZING: It is the process of arranging people and physical resources to carryout plans and accomplishes organizational objectives. This helps how responsibilities of individuals who are required to execute the works are defined and staffing and directing can be performed. Such things can easily be shown by the use of Organization Chart. Organization makes sure the flow of information resources and tasks logically and efficiently. Besides, the organization of sites, specifically to construction, together with the physical resources is also considered as the part of the organizing functions of management.

IMPLEMENTING: It is the process where by the actual work is executed. This helps in executing the task defined in the planning stage with proper organization system together with monitoring quality, time and cost of the works. Proper inspection and supervision, recording data of executed works, availing all necessary resources at the right place and at the right time with their proper coordination are necessary to achieve the required goal efficiently and successfully. The most important aspect in implementation of works is leading / directing. Leading is the act of motivating or causing people to perform certain tasks intended to achieve specified objectives. In general, it is the art of making things happen. Leading requires to understand the dynamics of individual and group behaviors, motivation of employees, effective visionary and effective communication capabilities.

MONITORING: Monitoring is the process by which executives and legislatives determine or evaluate whether organizational objectives are being achieved and actual operations are in consistent with plans or not. This helps for checking mechanism and used as a feed back for future planning. Such things are done against the planned data with the help of communication in the form of reporting, assessment and checking mechanism of any kind which is suitable for the purpose of the executed works.

Effective management can take place when proper planning, organizing, implementing, continuous communication, feed back for monitoring purpose and future planning are carried out successfully.

MANAGERIAL ROLES

According to widely known references, Henry Mintzberg brought forward three primarily managerial roles: Interpersonal, Informational and Decision Making Roles (Table ...).

Interpersonal Roles	These roles are related to formal authority base of managers.
Figurehead	Roles related to ceremonial in nature.
Leadership	Roles related to ensuring achievement of goals.
Liaison	Roles related to communication with internal and external stakeholders to develop favorable relationships and networks.

Informational Roles	These roles are related to availing sufficient information to carryout jobs effectively. Because they are information centers for information and communication source.
Monitor	Roles related to scanning internal and external environments of their organizations for selecting useful information.
Disseminator	Roles related to sharing and distributing useful information to employees.
Spokesperson	Roles related to information communications to external stakeholders.
Decision Roles	These roles are related to processing information to reach conclusions.
Entrepreneur	Roles related to initiating new developments.
Disturbance Handler	Roles related to conflict resolution and problem solving.
Resources Allocator	Roles related to distribution and assignment of different resources to projects.
Negotiator	Roles related to win comparative & competitive advantages to achieve goals.

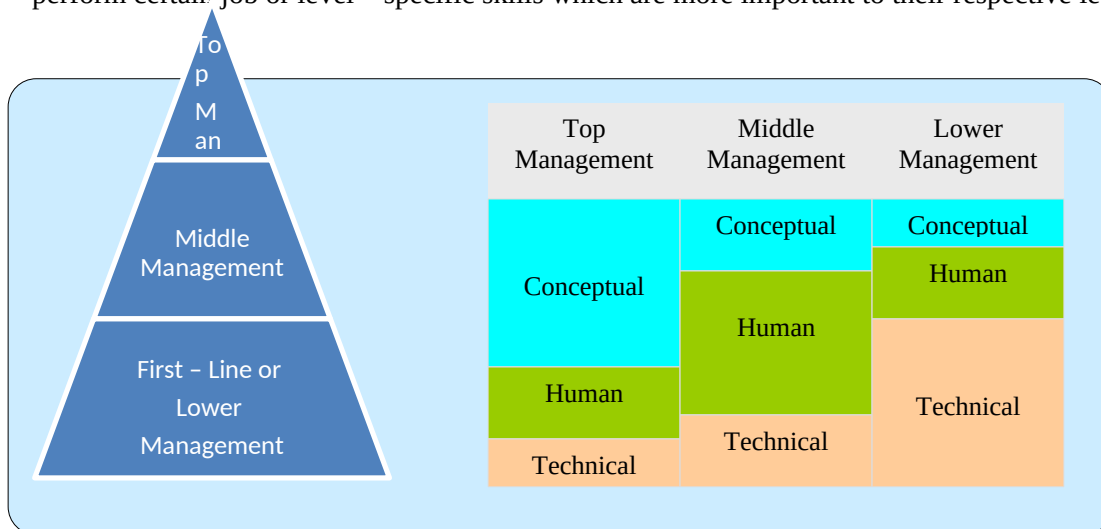
Besides, recent trends enlarged managerial roles due to changed environments such as:

- ✓ Globalization of markets
- ✓ Increasing predominance of Entrepreneurial Firms
- ✓ Growth in Service - based organizations
- ✓ Increasing Diversity
- ✓ New organizational Model, and
- ✓ Increasing customer focus

MANAGEMENT SCOPES AND LEVELS

Managers could be classified into different categories depending upon the scopes and levels of management they are involved in. Depending on the nature and scope of the job managers are performing, they can be classified under either functional or general managers. While functional managers are responsible for a work group segmented according to functions; general managers involve in managing several different functions or departments which are responsible for different tasks. While Functional managers greatest challenge is lack of communication skill; that of General Managers is technical skills.

Managers exist at various levels in the organizational hierarchy but are dependent on their sizes and forms. That is, while small organizations may have only one, big ones several layers. Generally speaking, a relatively large organization possesses three levels of managers: Top, Middle and First – line or Lower managers and could resemble pyramidal shape (Figure ...). These levels of managers do perform certain job or level – specific skills which are more important to their respective levels.



From the figure above, Technical skills are more important to lower management levels; Human skills are more important to middle management levels and Conceptual skills are more important to top management levels.

STRATEGIC MANAGEMENT

The increasing importance of strategic management may be a result of several trends. Increasing competition in most industries has made it difficult for some companies to compete. Modern and cheaper transportation and communication have led to increasing global trade and awareness. Technological development has led to accelerated changes in the global economy.

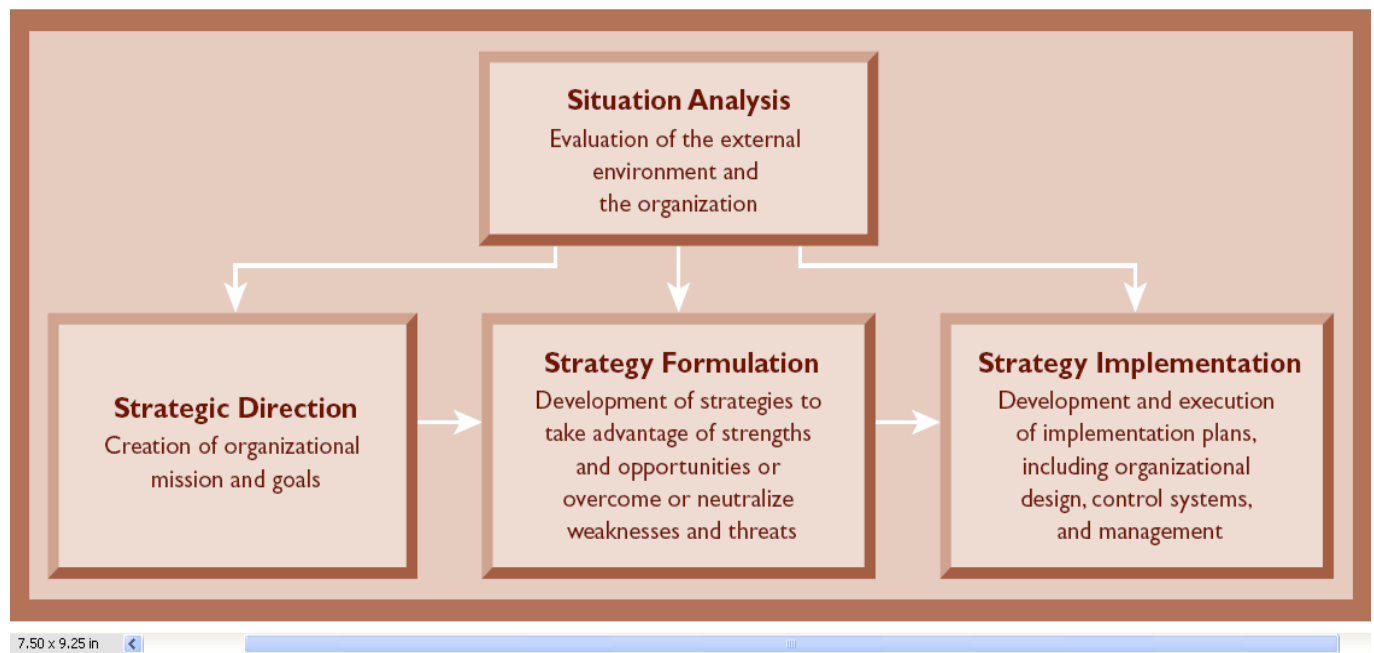
Many perspectives on strategic management and the strategic management process have emerged. Some of these perspectives are: (1) the traditional perspective, (2) the resource - based view of the firm, and (3) the stakeholder approach, which are outlined in the Table under.

	Traditional Perspective	Resource-Based View	Stakeholder View
Origin	Economics, other business disciplines, and consulting firms	Economics, distinctive competencies, and general management capability	Business ethics and social responsibility,
View of Firm	An economic entity	A collection of resources, skills, and abilities	A network of relationships among the firm and its stakeholders
Approach to Strategy Formulation	Situation analysis of internal and external environments leading to formulation of mission and strategies	Analysis of organizational resources, skills, and abilities Acquisition of superior resources, skills, and abilities	Analysis of the economic power, political influence, rights, and demands of various stakeholders
Source of Competitive Advantage	Best adapting the organization to its environment by taking advantage of strengths and opportunities and overcoming weaknesses and	Possession of resources, skills, and abilities that are valuable, rare, and difficult to imitate by competitors	Superior linkages with stakeholders leading to trust, goodwill, reduced uncertainty, improved business dealings, and ultimately higher firm performance

The key activities in the strategic management process are shown in Figure below and begin by providing:

- 1. A situation analysis of the broad and operating environments of the organization, including internal resources and both internal and external stakeholders**
- 2. The establishment of strategic direction, reflected in mission statements and organizational visions**
- 3. A formulation of specific strategies**
- 4. Strategy implementation, which includes designing an organizational structure, controlling organizational processes, managing relationships with stakeholders, and managing resources to develop competitive advantage**

1 Strategic Management Processes



➔Reading assignment on the above outlined three perspectives of strategic management and on the importance of strategic management!

CONSTRUCTION PROJECT MANAGEMENT

PROJECT AND PROJECT MANAGEMENT

INTRODUCTION AND DEFINITION

Project is ‘a temporary endeavor undertaken to create a unique product or service.’ (PMI). Generally projects are understood to be parts of the main business of organizations with the following identifying characteristics:

Temporary mean projects have got a definite start and finish. This implies, unlike many *operations* which are usually embarked with no clear end in sight (for example, AAU wasn’t established to end delivering education in some years’ time), many projects are incepted with a clear boundary when the project needs to be stopped. Normally, a project is terminated when either the objective is achieved or it has become apparent that it is no longer possible to achieve the goal the project is incepted for. As this point, it has to be emphasized that the temporary nature of projects doesn’t equate to short durations as many project last for quite a long time but still with a clear set up on when they are supposed to end.

Unique product implies the deliverables of an individual project are unique in nature. While there are many debates about the uniqueness of a villa built next door to the one built somewhere else, it has to be emphasized that each of the deliverables of the projects (the villa’s) do have quite a number of characteristics which sets them unique from each other.

Progressive elaboration implies that projects are developed in steps and continue to be elaborated and expanded as the work on the projects progresses. Accompanied with this, project works are usually iterative in processes where various feedback loops reinforce the previous processes and enhance the elaboration processes.

A component of a certain business implies projects are not an end to a goal by themselves; rather, they are a means to a goal. Thus, though not in strictly commercial sense, projects are usually incepted to stratify a certain *business need*.

Exercise: Compare and contrast *a project and an operation*:

The above being the major defining characteristics of projects, there are some categories of projects which may have some common characteristics to each other than others. In this context projects can be categorized in to three major groups (Lock 1987).

- Manufacturing projects,
- Projects requiring external organizations, and

- Management projects.

Manufacturing projects: These categories of projects are characterized by:

- original design work,
- prototype testing, if necessary,
- manufacturing,
- assembling, and
- installation and commissioning.

Except installation and commissioning works, most of the activities are carried out under the control of the manufacturer. Such projects are often made for a fixed price, promised delivery dates, and a set of unambiguous data – specifications – that define the performance.

Projects requiring external organizations: Such projects include civil engineering, construction, petrochemical, mining, etc; which aims to establish buildings or operating plant on required sites requiring external or supplementary organization to the mother organization on these sites. Such projects need more attention to the problems of communications and organization than the manufacturing projects.

Management projects: These categories of projects are service oriented projects rather than product oriented projects as the above two. In these category, the employment of an external manager or managing teams offering services to organizations:

- to ensure effective and efficient management system,
- to ensure efficient installation and start up of new approaches,
- to follow projects of the above nature on behalf of clients and / or financiers,
- etc.

A programme is a group of projects managed together for economic, convenience or otherwise reasons. It is often setup as series of projects linked together with a common purpose. For example, a certain city may initiate a slum upgrading programme which could incorporate various projects as in housing development projects, infrastructure (each could again sub divided into other projects) delivery projects, etc. Similarly, programmes can also be initiatives that incorporate projects of similar nature. For example, the now famous ERA's Road Sector Development Programme is a collection of enormous projects bundled together and run accordingly. Such an approach to delivery of infrastructure may provide a means of *integration among different projects* and ways of *tradeoffs between the various projects*. In fact, it is a very important way of delivery especially for huge and complex initiatives where various projects have to be coordinated and traded-off to provide the best value for money spent.

When a firm is managing various and usually unrelated projects or programs at the same time, it is said to be performing **portfolio management**. Thus portfolio management involves identifying, prioritizing, authorizing, managing and controlling of *portfolios* of projects, programs or other related works to achieve specific strategic business objectives.

Project Management, as it is defined by the global project management body, PMI, is ‘the application of knowledge, skills, tools, and techniques to project activities to meet project requirements’. These sets of skills, knowledge, tool, etc, which may vary from project to project and area to area need to be applied in an integrated manner throughout *the life cycle of the projects* to meet the *project requirements*. Thus, in a nut shell, project management is a systematic way of applying ranges of sets of knowledge, skills, etc to achieve project objectives in a best possible way. It is a methodical approach to planning and guiding project processes from start to finish.

THE DEVELOPMENT OF PROJECT MANAGEMENT

Associated with the construction of the Great Pyramids of Egypt and the Wall of China, the history of project management is often dated back to time immemorial. However, despite archaeologists’ suggestion that the construction of the Pyramids were one of the largest ‘fill-in jobs’ ever undertaken by mankind, and with no documented evidence, discussion of the management techniques used can only be conjecture.

Modern day project management traces its root to Henry Gantt’s development of the bar chart, otherwise known as the Gantt chart, in the early 1900s. However, project management as a management ‘discipline’ or recognisable body of knowledge only emerged during the 1960s when companies in the construction, defence and aerospace industries started to use tools and techniques- such as the critical path method (CPM)- requiring new sets of skills, knowledge and expertise to be developed in their application. Even at this stage of development of PM, it was the use of specific tools and techniques such as CPM that was the focus of attention rather than the use of a holistic strategic approach of management of projects.

More recently, beginning in the late 1980s and early 1990’s, companies from different sectors (which were originally not known for a project-based production) such as manufacturing, the IT, the leisure, nuclear, health and pharmaceutical, mining, oil and gas, have started to embrace management by projects way of conducting business as a potential source of competitive advantage. There are a variety of reasons put forward as to why this shift occurred including:

- Rapidly changing environments, fierce competitive markets, powerful environmental lobbies etc. all encouraged companies to look for a more agile and adaptable models of management.
- The tasks that organizations were facing had become more complex and cross-disciplinary demanding more sophisticated and flexible organizational approaches.
- The size and scope of projects (in different industries) had required the development of more effective management systems for planning and controlling project performance, schedules, and cost/budget, etc

Thus, along with the development of general project management, which could be applied to manage projects in any industry, construction project management is now becoming an attractive discipline for training. As a result, it has established itself as one of the core disciplines in academia whereby an increasing number of project management institutions and associations offer education and training in contemporary PM principles and conduct research

to capture and formalize accepted practices into the global body of knowledge and curricula of certification programmes.

In its relatively few years of modern existence, project management has gone a major evolution to suite the current state of technology and society's demands.

The Traditional Project Management Approach: It is worth to credit the traditional project management system that helped to achieve enhancement in the development of the world in this aspect. However, the changing environment internally and externally to organizations gives rise to complex and an uncertain situations that cause to see into the pros and cons of the traditional project management system. This can easily be conceived in viewing through its failures to adapt to the new situations. The problems in the traditional project management system fall into three distinct items (Davidsen Frame, J., 1994):

- Its inattention to the importance of customer satisfaction: In the traditional approach customer satisfaction is often treated as an after thought. It is directed towards satisfying the famous triple constraints: **Time, Budget, and Specification or Performance**. Hence, success and failure are typically assessed against these three constraints. There is a general trend and acceptance in the traditional approach that customer satisfaction can be fulfilled through the third constraint – Specification. However, practical experience showed that it failed to take adequate account of customer needs and wants. This is largely because specifications are created by experts who:
 - lack the skills and training to work with customers,
 - don't understand the customers' business,
 - design and build products that are personal interest to themselves, and
 - often drive to establish specification that will gain them the admiration of their fellow experts.
- Its single minded focus on a fixed set of tools for dealing with scheduling, budgeting, and resource allocation: The fact that the traditional approach being single-minded in these fixed sets of tools makes mastery of these tools are likely to be a good project management approach. There is nothing inherently wrong with tools mastery, but the problem lies in their excessive concern leading to diversion of attention from other matters such as motivating employees, acquiring political skills and managing and satisfying customer needs. The reality is that projects seldom fail due to failure in using these tools, but frequently for non-technical reasons:
 - lack of commitment on the part of the staff,
 - political gaffes, and
 - the inability to communicate ideas effectively.
- Its narrow definition what it should be concerned with:
 - a. Traditional project management often limits the project life cycle to four phases: concept, planning, execution and close out. With this life cycle, the project team members can wash their hands of the deliverables after it is handed over to the

customer; Which is the most practical problem for construction activities in customer satisfaction.

For customer satisfaction, the life cycle shall be extended to include one more phase: **Operation and Maintenance**. This way, the project team members are made to realize that their job is not only to build but also to assure that it works in a satisfactory way after it is delivered.

- b. Traditional project management holds a constricted view that primarily sees project managers as implementers. Often, project managers do not involve in the decision making process at the inception phase of the project rather it is handed over to him, whose charge is to do the job within the pre-determined scope. Such a limited view to project managers creates an environment that is difficult to serve the customer effectively. If an important goal of project management, the project manager's role shall be redefined to allow it to be achieved.

The traditional project management has served this world to its best well. The new changing environment however required this approach to adapt through changing some of its concepts and adding relevant management tools and theories in order to adjust to the powerful global competitive forces and new conditions facing organizations this time. It is this fact that led theorist and researchers to see into the new project management approach.

The Modern Project Management Approach: The new project management recognizes most of the traditional approaches are still relevant to today's changing environment. Therefore the new approaches rather than establishing its own total frame of assumptions, it aims to enhance the traditional approach by aligning it with the new business in the world. These alignments fall into three basic and central issues of the new project management system (Davidsen Frames, J., 1994). These are: project management shall

- Become more customer focused: Practice proved that the worst kind of failure in project management is carrying out projects that do not satisfy the beneficiaries. If projects are carried out in accordance with the needs and wants of the customer, it is then be called that the project management becomes more customer basis. The main reason behind this is that it is the customers who finally evaluate the deliverables while in operation or before on the basis of the following compelling criteria:
 - 1. satisfying customers need towards receiving expected products and services,
 - 2. when customers made success out of the deliverables, there increases the likelihood of repeat business,
 - 3. when customers look for similar projects for repeat business, they usually chose to contract with those reputable contractors with strong customer focus, and
 - 4. customer satisfaction is for ideal closure or completion of projects rapidly.

Here one can notice two basic key words – customer and customer satisfaction. Who are the customers?, and what are the factors that most influence the customer satisfaction? This key aspects will be dealt in detail in part of this paper: Customers and the Critical Success Factors.

- Explore the use of new management tools: Besides the primary tools that are used by the traditional management tools – scheduling, budgeting, and allocating resources -, there comes a need to acquire nontraditional project management skills. These tools fall into two major groups: Hard skills and Soft skills. The hard skills include the basics of contracting, business finance, integrated cost-schedule control, measuring work

performance, monitoring quality, and conducting risk analysis. And the soft skills include negotiation, change management, politically astute and understanding customer needs.

- Redefine the role of the project manager: Neither stable nor free from competition, today's business environment could not fulfill its intended purpose successfully with the traditional approach thinking of project managers as pure implementers. Therefore, there arises the need to redefine the role of the project managers. This is literally **project managers input in project identification, preparation, appraisal and negotiation and approval stages of the inception phase of the project cycle is very necessary**. Besides project managers shall become more customer focused, and be empowered with the necessary authority to operate effectively.

Projects (including construction projects) are carried out using identified project phases. Project phases are understood as the processes at which projects are formulated, implemented and completed. These processes are well understood in many literatures as *The Project Life Cycle* under Process Management.

PROJECT LIFE CYCLES AND THE KEY PLAYERS IN EACH PHASE

During their execution time, projects pass through various phases. Though, there are not universally agreed concrete separations of the various phases that projects have to pass through, what normally happens is that:

Projects are started with some business plan which could be influenced by some *pre project* events that could spur the performing company about the opportunities and problems and to explore them via feasibility study. During such *conceptual* stages the explorations lead to possible ways of acquiring the business plan's objective or even abandon it. Such endeavors, in the business context may lead to *discounted cash flow* (DCF) analysis to come up with the best selected project that benefits the performing company best.

The outputs of the conceptual phases are further developed during the *design and planning (development)* phase to make them ready for implementation.

The *implementation* phase interprets the planning and designing outputs and changes them into real artifacts.

Finally, the final product is commissioned and the project is closed out during the *commissioning and closing* phase. Collectively, these whole phases of a project, from conception to close out, are said to be the *project life cycle*.

At this point, it has to be highlighted that the above phases are not universal to every project. Many implementing agencies may merge the various phases, or abandon them, or execute them without clear cut distinctions.

Transitions from one phase to another generally involve handoffs of some concrete deliverables. Normally, deliverables from one phase reviewed for completeness and accuracy and approved before work starts in the next phase unless *fast tracking* is thought to be necessary. Under fast

tracking circumstances, phases may merge and hence issues are dealt with in a concurrent manner providing opportunities to take advantages rendered by *concurrent engineering*.

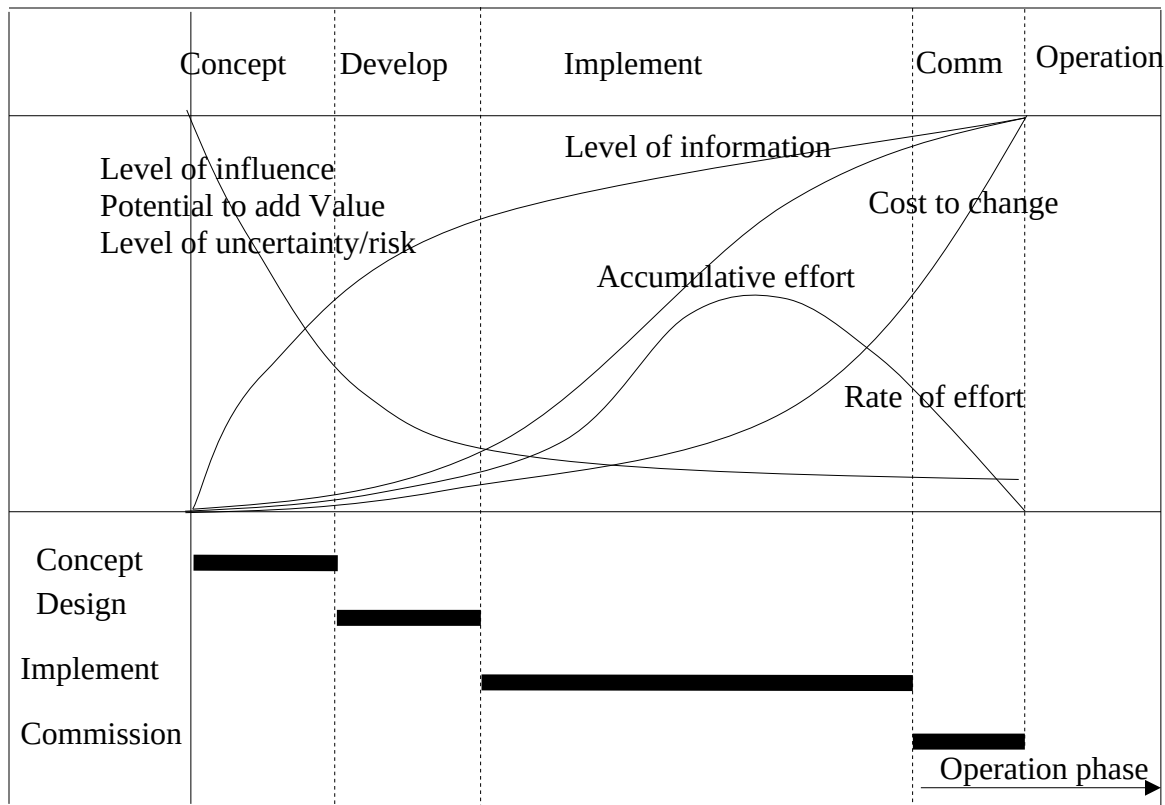
Project life cycle

Project cycles various	Concept	Development	Implementation	Commission	life have
	Input				
	Problem or opportunity, project brief, project charter	Approval to go ahead with design and development	Approval to implement project	Commissioning plan, notification of completion	
	Process				
	Feasibility study	Design product, develop detailed programme: WBS, CPM, budget	Solicit tender and award contracts, administer contracts, make the product/solve problem	Start-up and test the product. produce as built drawings, compile knowledge learnt	
	Major Players				
	Client, Economic advisor, Project Manage	Client, Project Manager, Designer, regulatory bodies	Client, Project Manager, Consultant, Contractor, Suppliers	Client, Project Manager, Consultant	
	Output				
	Feasibility study, Project proposal, Execution strategy	Baseline plan, design drawings and specifications	Completed project output	Project closeout report	
	Approval				
	Go/no go decision	To implement project	Ready to commission	Deliverable accepted	

common characteristics:

- The ability of stakeholders to influence the final characteristics of the project's product and the cost of the project decreases as the project moves forward. Related to this, cost of change to the project increases
- As projects move through their life cycle, the uncertainty about that project and hence the risk of failing to achieve objective decreases. In contrast to this, information about the project grows as the project moves forward from phase to phase.

- While the cumulative effort increases as the project moves forward, the rate of effort/cost (level of staffing) is generally the highest somewhere at the middle of the implementation stage.



Level of Influence Vs Cost of change (front end importance)

Major players in each phase

The traditional project delivery approach in construction is accused of being fragmented where each party mainly comes into view after a certain phase is complete. In the system, for example, contractors don't come into view until project designing is finished. However, it is argued quite convincingly that, clients don't get best value for their money under this system is modified to scrape the *fragmented and sequential* approach to delivery. It is argued that *inter-phase management* and involvement of such critical implementing party during the development phase is of greater value for projects. Thus, the modern approach to project management is that, project managers, who traditionally are not brought into view by themselves up until the implementation phase, should take the overall responsibility of implementing the project from inception to completions. The merit of such an approach is that, it will provide a *single point of responsibility* and helps in inter-phase management thereby coordinating and facilitating involvements of all parties in providing valuable contributions

during the development stage of the project. That said, the major parties that play a significant role in each phase of the project are presented in table 3:1 above.

PROJECT Vs PRODUCT LIFE CYCLE

Many projects are incepted to create a certain product at the conclusion of them. Generally projects are incepted in response to some sort of problem, opportunity or business requirement. Hence, they normally produce a product which outstrips their life cycle. The whole life cycle of the pre-start of a project and abandonment of its product is termed the *product life cycle*

Under normal circumstances, especially for projects implemented in the construction industry the product life cycle entails:

The *pre-project* phase: As highlighted earlier, projects are usually triggered by some form of events experienced/envisaged by the implementing company. These pre-project events are very crucial in determining whether an implementing company has to start a project at all and/or determine the scale of the project. Thus, managing the pre-project environment is fundamental for the implementing company to take advantage of situations when they occur.

The project life cycle: (See above)

The operation life cycle: Generally projects end up with a formal handover of the products delivered and the associated documents for knowledge learned and running documents. After that the product delivered thereof usually undergoes through various adjustments while (or closed for a while) providing its purpose: The major phase of which are:

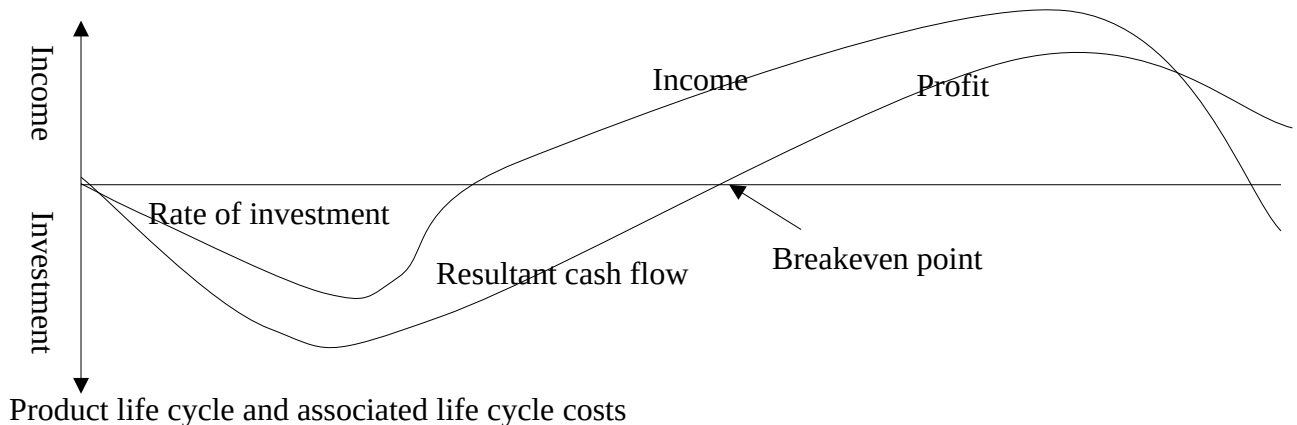
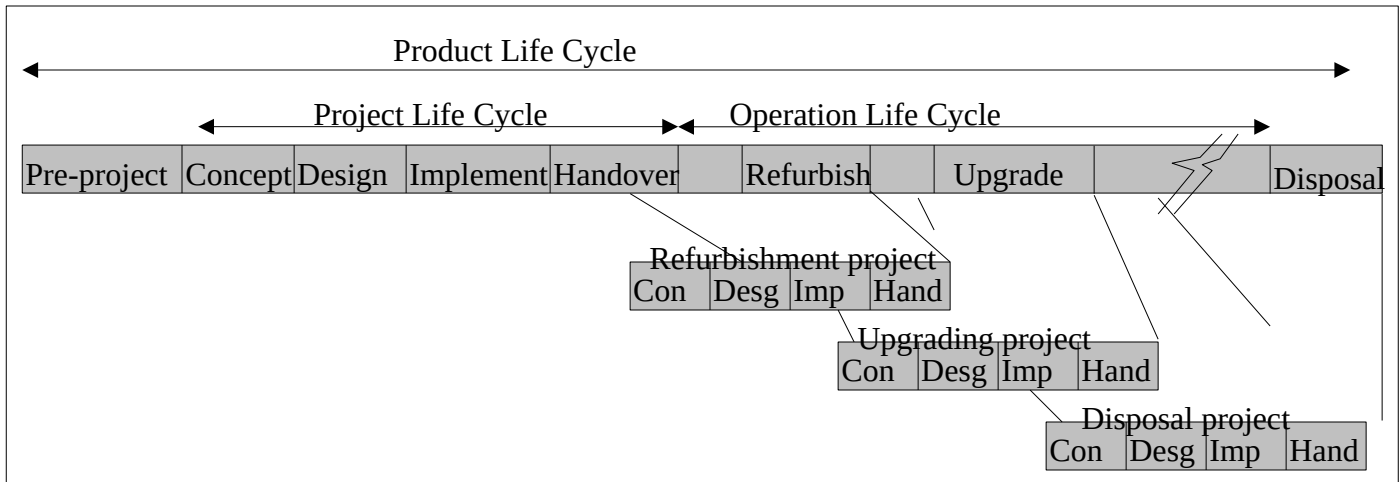
- A *maintenance (refurbishment)* phase: The product delivered needs to be looked after continuously and maintained for it to efficiently deliver its purpose.
- An *upgrading (expansion)* phase: At some point in the product's life cycle, it may be necessary (for economic reasons or otherwise) to upgrade the product.
- A *disposal* phase: In some products (such as waste treatment plants, nuclear plants, etc) it may be necessary to have an organized disposal mechanism when the product finishes its life time or when it is not needed any more.

Product life cycle and life cycle costing

The classic project life cycle only considers project from conception to handover. However, if the project is that of producing product, it is usually some sort of facility. In construction projects, from the client's point of view, the efficient operation of the product and its rate of return on investment (ROI) should be analyzed by taking into account the product life cycle.

Formulating a project with a clear picture of the whole product life cycle will have a huge impact on the success and failure of the overall endeavor. For example, by looking the big picture, the designers of the project will be able to consider the trade-off cost of construction

with that of cost of maintenance, upgrading (expansion) and disposal of the facility. Such approach of looking into the overall cost and return of the facility is known as *life cycle costing*. Thus, when project managers *value engineer* different alternatives in selecting the most appropriate way of delivering a project, it is of paramount importance that they analyze them based on the *product life cycle costs* rather than the simplistic *project life cycle cost*.



PROJECT MANAGEMENT PROCESSES

Project endeavors involve executing intricately interwoven *processes* to achieve objectives. *Processes are sets of interrelated actions and activities that are performed to achieve objectives*. Thus, construction processes are all processes which guide towards completion and are a presupposition for the planned construction works. In project environments, such processes usually fall in two categories:

- A. The *project management* processes: are processes which are common to most project most of the time and are associated with each other by their performance for an integrated purpose of **initiating, planning, executing, monitoring & controlling** and

closure of projects. These processes interact to each other in a complex way that can only be modeled partially. Thus the onus lies on the project management team to properly identify and execute the processes needed for an efficient performance.

- B. *Product oriented* processes: are processes that specify and create the project's product. Such processes are typically defined by the project life cycle and vary by application area. For example, the processes that need to be executed to implement a certain hydropower project may be quite unique to that specific project, even though most of the project management processes could be common. Such processes that involve setting out, excavation, concreting, asphalt laying etc are typical product oriented processes in a construction work.

In a project work, the project management processes and the product oriented processes must interact efficiently and appropriately aligned with other processes throughout the project to achieve the objective. These interactions may demand *tradeoffs been requirements*.

In this section we will only be discussing project management processes which are common to most project most of the time. The product oriented processes need specific focus and are not presented here.

Project management processes, as presented by the PMBOK, involve groups of initiating, planning, executing monitoring & evaluation and closure processes. They are concepts presented by Deming's plan-do-check-act cycle and modified to suite nature of projects. Unlike the Deming's cycle, projects have a definite start and finish; hence, as shown in the fig. below, there have to be an initiation and closing processes. Accordingly, the major processes in project management are:

- **The initiation processes:** are the processes needed to define and authorize the project or its phases. The major project management processes in this process groups include developing project charter and developing preliminary project scope statement. Accordingly, the major outputs of such processes are the *project charter and preliminary scope statement*. In simplistic terms, the initiation processes start a project or phases of a project and with clear outputs of the project's purpose, its objectives and command of the project manager.

A project charter (a ToR) is a tightly worded document outlining what is to be done and the boundaries of the project. For example, most part of charter from a client can be summarized as: to build an 80,000 seator stadium in Addis, to Olympic standards, to be completed six months before the next CAF African Nation's Cup tournament, for X million birr.

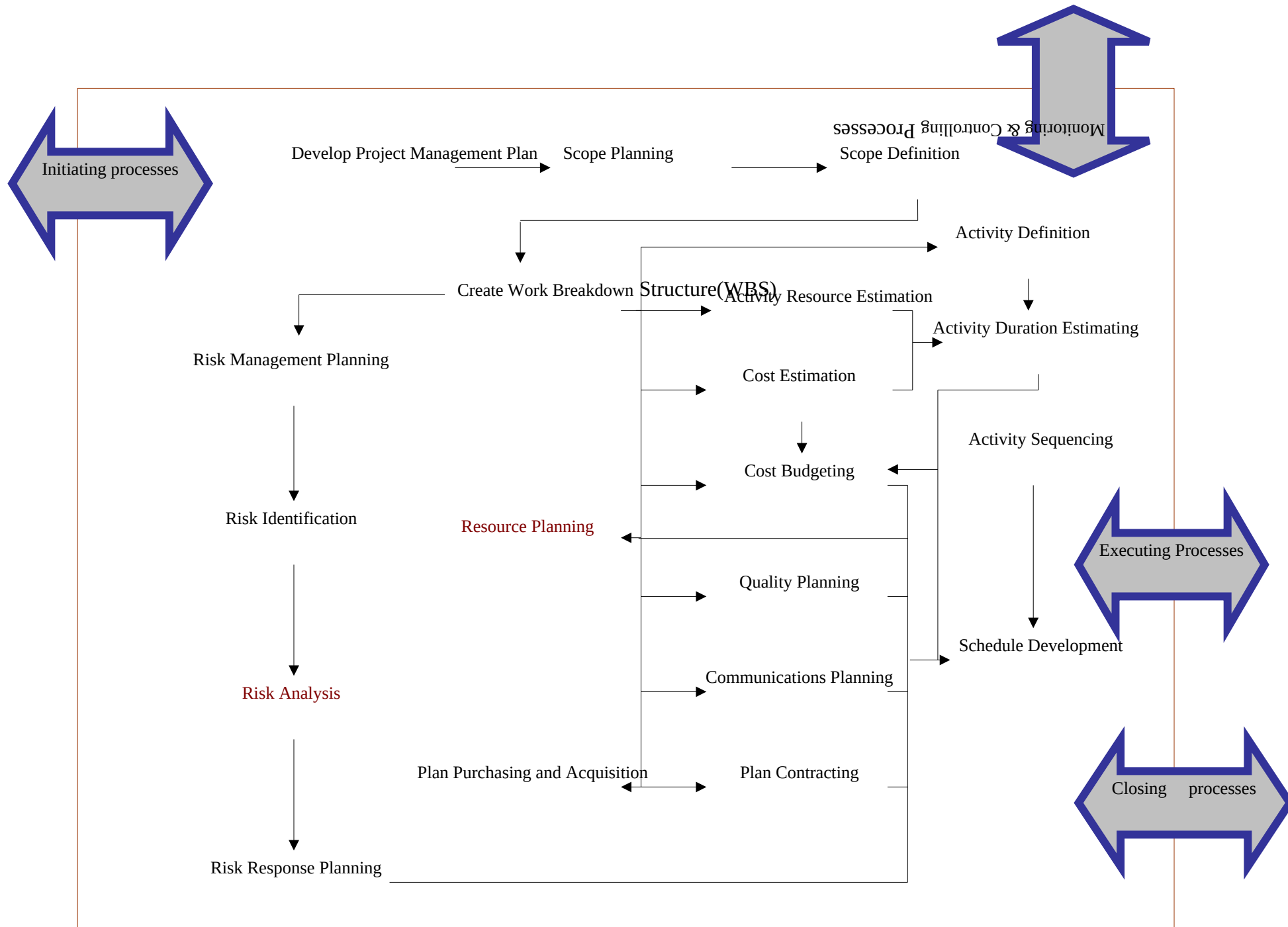
A project charter should generally include:

- Background to the project
- Key assumptions
- Business needs and other commercial needs
- Scope pf work

- Identify key activities, budgets and milestones
 - Comment on how the project is to be managed
 - Etc
- **Planning processes:** are processes that define and refine objectives and plan courses of actions required to attain the objectives and scope that the project is undertaken to address. The planning processes define the project **scope, cost** and **activities** along with the **resources** needed to execute the activities, the **time** they need to be executed and how they need be **managed and coordinated**, developed into a document called the **project management plan**. In simple terms, planning processes are processes needed for a systematic way of deciding in advance *what* is to be done in *what amount*, *how* it is to be done and by *whom*, *when* it is to be done and *how much* it costs to achieve the project's objectives. Developing the project management plan requires various information to be gathered from ranges of stakeholders, and interactive and integrative activities with intricate interlinks. By nature, planning is not a one off thing. It normally demands progressive development of the plan through various cycles of feedbacks and reinforcements. The planning process groups include the following project management processes:

The major deliverables of the planning processes within the framework of the project management plan includes:

- ✚ Scope plan that incorporates all the works and only the works required to complete the project and to the quantity they need to be executed;
- ✚ Quality plan that sets out all the quality standards, specifications, manuals, etc that need to be adhered to or referenced to assure that quality of the processes and the product delivered thereof;
- ✚ Time plan which sets up the *time frames* for the execution of each activity in such a way that the project *satisfies the projects constraint of time*:- where by it shows the calendar day tailored start and finish dates of each and every activity as well as satisfies the constraints that could be incurred on specific activities and on the overall project;



The major planning processes: Adopted from PMBOK

- ✦ Resource plan that indicates all the resources required for the execution of the project in terms of *type, amount, time frame* needed as well as when/how the deployments needs to be done;
 - ✦ Procurement plan, based on the extent of the *buy or make decisions* that need to be made, should indicate and provide clear indications as to how procurements are need to be made and when they need to be made;
 - ✦ Communication plan that shows the formal line of communications in terms of the *Organization Breakdown Structure (OBS)* as well as its responsiveness with informal ways of communications. The plan also need to show the responsibilities and accountabilities of each party best depicted on *Responsibility Assignment Matrix (RAM)*;
 - ✦ A risk management plan that indicates the possible ways of managing potential risks;
 - ✦ Cost plan that *satisfies expected budgetary limits* with the prices and resources deployed to each and every activity and the *cash flow* properly set to agree with the performing company's expected cash income;
- Executing processes: are processes that need to be executed to achieve the project requirements. These processes address that project scope and any changes that entail thereof are implemented according to plan or its modification. The execution of these processes requires project resources and hence consumes the bulk part of the project cost. The processes, to be more efficient and coordinated, need to be executed in accordance to the project management plan. However, under normal circumstances, execution may indicate some variations which need to be monitored and acted accordingly. While this stage incorporates quite many product oriented processes that actually implement the project, its major project management processes include, team acquisition, information distribution, etc.
- Monitoring and controlling processes: are processes performed to 'monitor' project execution, check if there are any deviations from plan, evaluate effects of deviation and implement possible courses of actions along with providing strict control to avoid variation in the first place. As the famous quote from the former US president Eisenehor goes 'plans are nothing but planning is everything.' In his speech, the president was emphasizing the importance of planning and the equally importance of acting according to plan. In real world of project implementation, most often than not, projects drift from plan. Therefore, for project management team to successfully stir their project to completion, it is vitally important that they continuously track their project and keep it up-to-date. Tracking project progress and comparing it with *baseline plan* helps identify potential drift from the baseline and make appropriate measures early on during the life cycle of the project. Therefore, it is of paramount important that the project implementation team has well-trained personnel at their disposal to update the plan and spot on drifts as early as possible and recommend possible courses of actions. The major tasks that need to be done in monitoring and evaluating includes: scope verification, scope control (also commonly known as *configuration management*), schedule control, cost control, perform quality control, performance reporting,

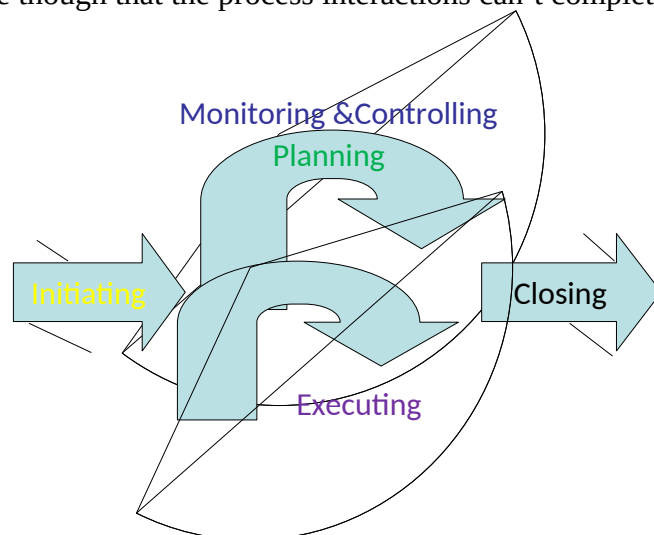
manage stakeholders, contract administration, etc. *Configuration management* is a collection of formal documented procedures used to apply technical and administrative direction and surveillance to identify and document the functional and physical characteristics of a product, output etc; control any changes to such characteristics, record and report each change and its implementation status; support the audit of the product to verify conformance to requirements. It includes the documentation, tracking systems and defines approval levels necessary for authorizing and controlling changes.

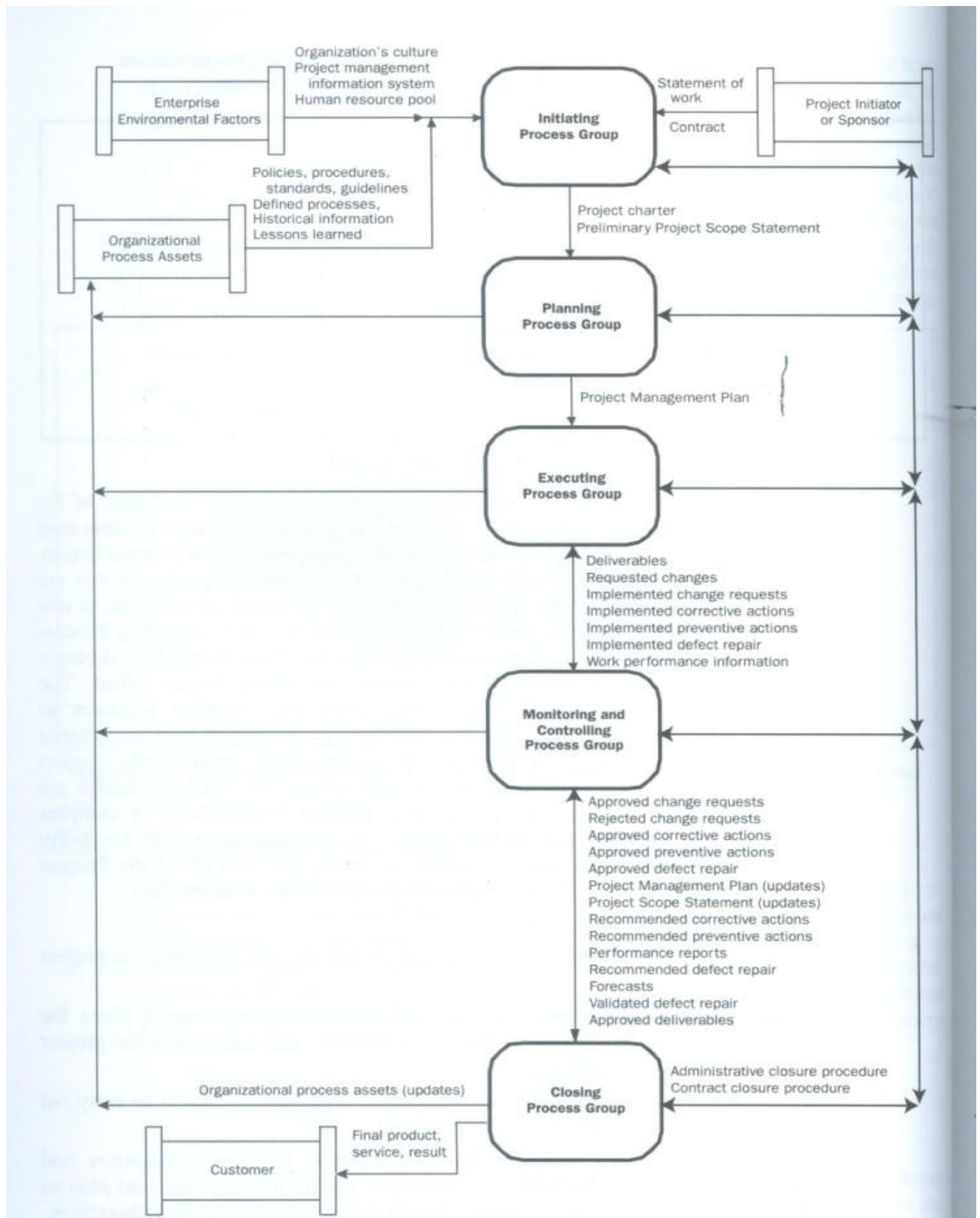
There are various monitoring and evaluating mechanisms available: They include, progress (status) reports, change order formats and requirements, configuration management formats, performance evaluation mechanisms and reports, time sheets, earned value analysis, etc.

- Closing processes: are processes that need to be executed to bring the project (or its phase) to a formal closure. The processes verify that project (phase) endeavors are completed or certify that it is no longer possible to achieve project objectives and hence has to be terminated. They include *project closure and contract closure* whereby as built drawings, operating manuals, lessons learned, etc are compiled and handed over to the client and certification are provided for acceptance of the works as part of releasing from contractual obligations.

Interactions among the phases

Unlike the plan-do-check-act cycle in Deming's model, the project management processes are very interactive in nature. Normally, the output of one process becomes an input to the subsequent one. For example, the planning processes provide the executing processes the project management plan based on which the latter is executed. Besides, the interactive nature of project works demands the monitoring and controlling processes to interact with every other process and hence plans need to be *updated* as the project progresses. Adopted from PMBOK, the figure below depicts the interactions among the processes and the major inputs, flows and outputs of the various processes. It has to be iterated here though that the process interactions can't completely be modeled here.

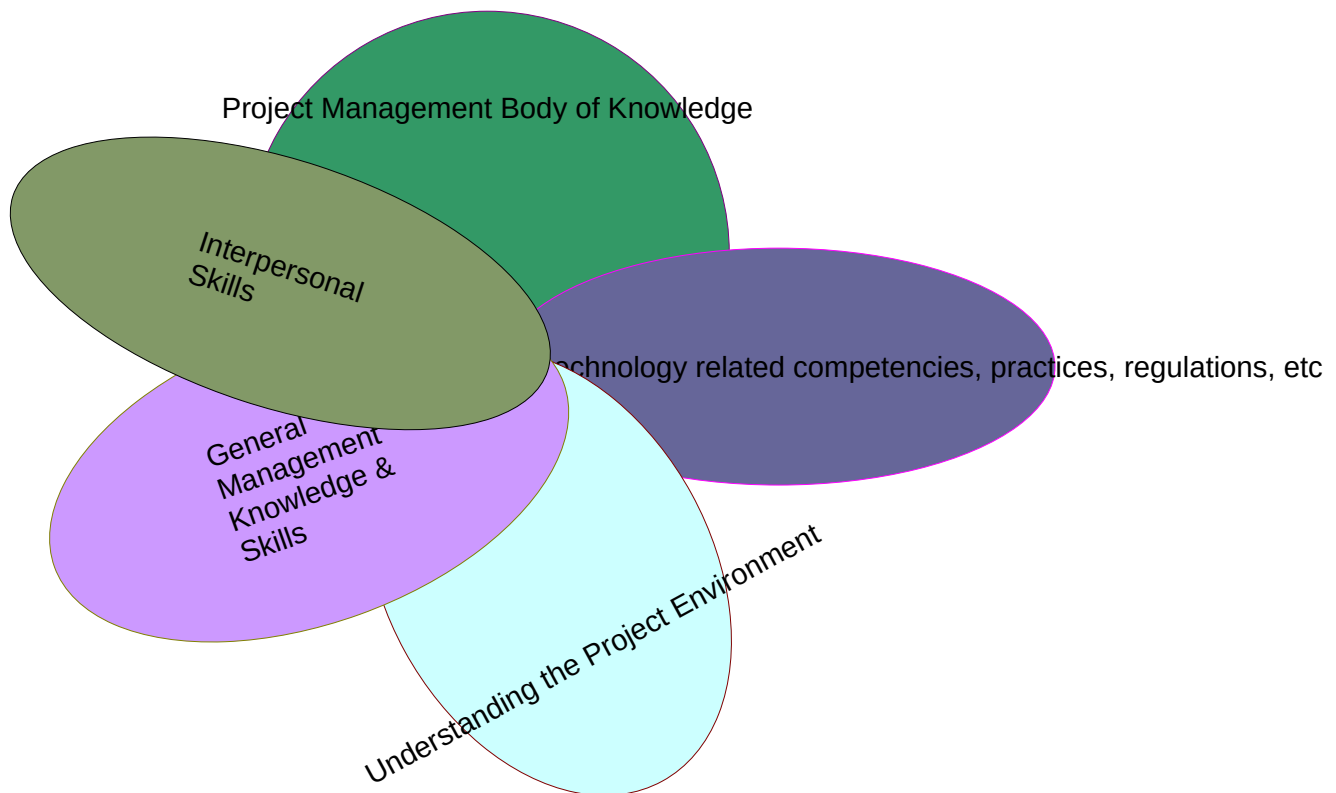




INTRODUCTION TO KNOWLEDGE AREAS OF PROJECT MANAGEMENT

MAJOR SKILLS NEEDED TO MANAGE PROJECTS

Construction project works are complex endeavours that demand various technical, managerial, and other capacities for their success. To be successful in a project work, the project management team need to setup itself in such a way that they have all the major capacities and competencies necessary to accomplish the work at hand efficiently and effectively. Moreover, the team should also understand that, hence setup itself accordingly, the fact that such capabilities are not uniform throughout projects, with some of the competencies necessary perhaps unique to that specific project. However, generally, the major competencies and capabilities needed on projects can be described in the interlinked areas as shown below.



i. Project management body of knowledge

Managing construction projects to success demands various project management knowledge, technique, skills etc. In these regard, the project management team needs to develop appropriate capability in terms of such project management competencies throughout the project life cycle as it is appropriate. Such competencies include, but not limited to, the appropriate application of above process and the various aspects of knowledge areas such as scope management, time management, cost management, quality management, resource management, communications and stakeholders management, procurement management, risk management, etc. Moreover, the

project management team should have the capability and competency to integrate these various competencies needed to get the best out of the whole system.

ii. Construction industry & technology related competencies, practices, regulations, etc

Execution of construction projects demands, above project management competencies, various other capacities and competencies specific to construction. Appropriate deployment and utilization of such technical, regulatory, standardized competencies are fundamentally important for the success of the project. Though fundamentally similar in nature, the appropriate utilization of such skills even may demand experience into the specific sector the project can be categorized as in road sector, building sector, water works sector etc. Thus, it is fundamental that the project management team sets up appropriate level of such construction technology, practice, regulations, etc competencies for its project.

❖ Construction technology

Buildings sector works, road works, water works, etc technical and experience demands; Construction material and equipment management practices (Selection, deploying, proper utilization, Maintenance and fleet management, demobilizing), etc.

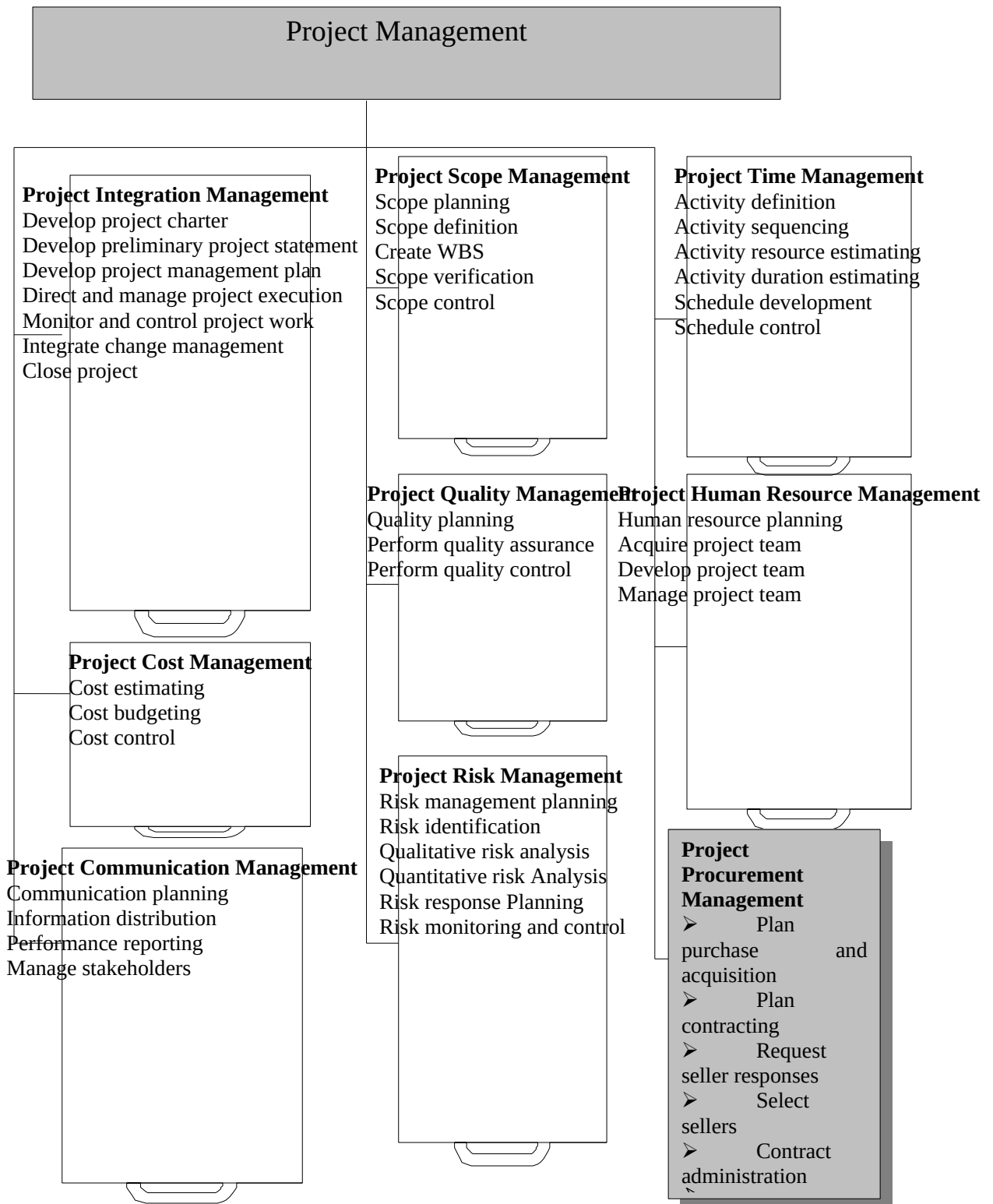
❖ Construction regulations and standards

Proclamations, construction (building, road, water works etc) code standards & specifications, resource requirement and productivity norms, etc

❖ Construction procurement and contracting practices

Delivery mechanisms (DBB, DB, CM, PPP), price contracting mechanisms (Lump sum, unit price, cost plus etc), Procurement and contract procedures and requirements (PPA, MoWUD, FIDIC, WB, AfDB, EEC)

❖ Other issues such as environmental impact, health and safety concerns, etc



Overview of Project Management Knowledge Areas and Project Management Processes

Thus, it is fundamental that the project management team sets up appropriate level of such construction technology, practice, regulations, etc competencies for its project. Moreover, for it to be able to have a commanding managing and coordinating capability, the project manager

him(her)self has to have these competencies to the various levels of understanding. Such levels of understandings needed, as classified by Bloom and co are:

Level 1: Knowledge: Can talk about concept, process, tool or context in words and can regurgitate definitions or descriptions. Has some sense of what information is relevant / irrelevant. **Level 2: Comprehension:** Can follow what is being communicated and can use information without seeing its relationship to other material or recognizing greater implications. Can construct simple mental model regarding new information; can process answers to critical inquiry and articulate what is understood as well as what remains confusing. **Level 3: Application:** Can apply and transfer particular item of knowledge to different situations and contexts. Can generalize the knowledge and determine ways to apply it, testing boundaries and linkages to other information. Can recognize situations and skillfully make use of this knowledge in new contexts and situations. **Level 4: analysis:** Can divide a problem into its component parts in order to clarify the relations among these parts. Can integrate the knowledge skill with other knowledge skills to produce a generalized solution. **Level 5: Synthesis.** Can put pieces of information together to form a whole, such as a researcher would develop knowledge to a new level of understanding. Can use lateral thinking to make new linkages among concepts and problem solutions which have not been seen before. **Level 6: Evaluation.** Can make judgments about the extent to which a product satisfies stated criteria. Can compare newly processed information with a rich set of relevant background information to discern its relative contribution and wisely rank and select the best use for the information.

iii. Understanding the Project Environment

Projects are incepted, planned and executed in politico-socio-cultural-economic, etc environment whose toll on projects can't be neglected. Thus, the project management team should be aware of this wider contexts such as effect (economic, cultural, social, etc) of the project on the local and global population, its socio-economic significance, its physical (and its effects) environment, its political (both local and global) implications, etc and take an appropriately tailored measure to make the best out of the situation. Put simply, having to manage a project here in Addis doesn't entail same challenge as having to manage another project is say Afar region.

iv. General Management Skills

Management involves planning, organizing, staffing, executing and controlling *operations*. It incorporates such supporting disciplines as accounting, financial management, purchasing and procurement, supply chain and logistics management, operational planning, organizing and organization behavior, personnel administrations, compensations, etc. The majority of these skills do complement project endeavors and hence need to be mastered.

V. Interpersonal Skills

As it is often defined; management is simply 'getting things done through others.' This quite simplistic definition implies that it is crucially important that the project management team have got the interpersonal skills needed to get things done. The range of such competencies incorporates effective communication, leading a team, motivating people, negotiation and conflict management, influencing organizations and playing the right politicking, critical thinking and problem solving skills, etc. Thus, project managers should try to develop such competencies in their aspiration to deliver successful completion of project on a consistent basis.

In summary, every project is unique by itself. Accordingly, the challenges and competencies it demands vary with it. Therefore, it is up to the project management team that they set up their team to have adequate competency, authority, and responsibility to successfully deliver the project. Moreover, the team need to realize that some of the competencies needed may vary along the phases of the project and as time pass. Put simply, projects are managed in a real world in a real time where various unforeseeable conditions may arise. Having the right technical, managerial, psychological, etc capability to manage situations as they arise is what differentiates a good project team to a bad one.

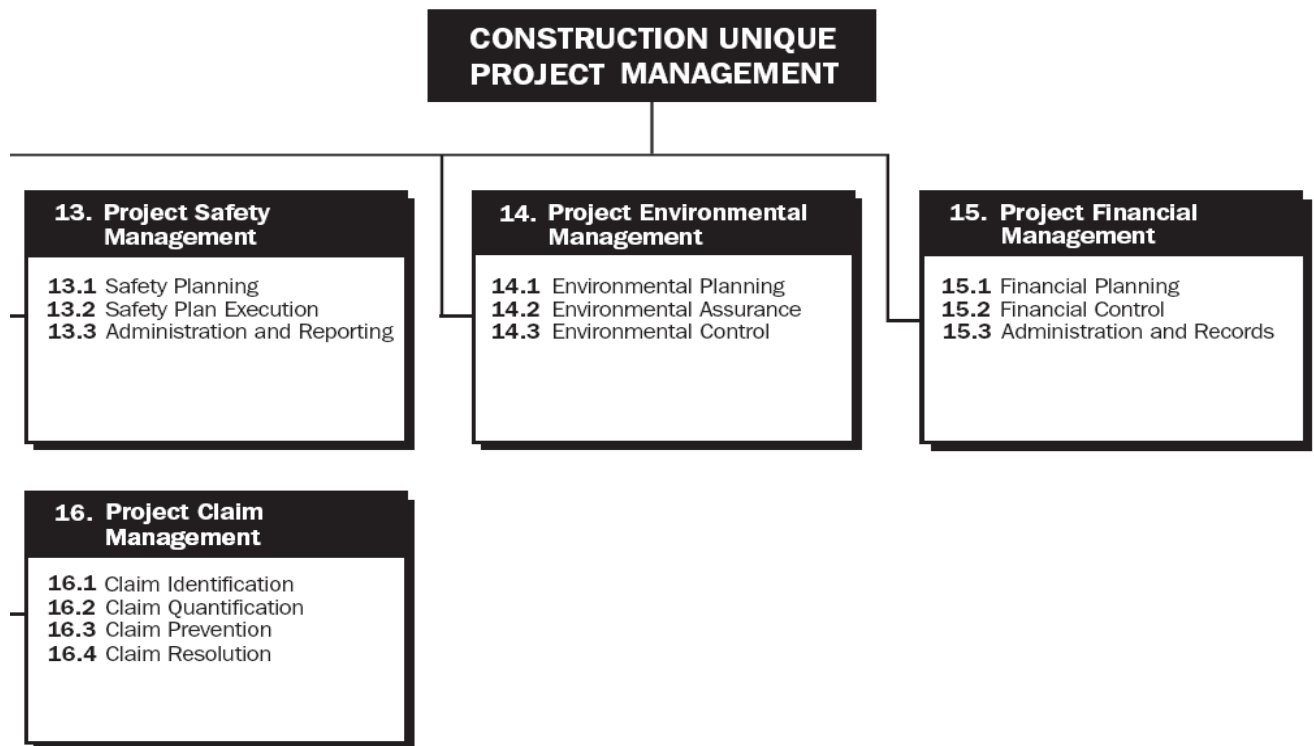


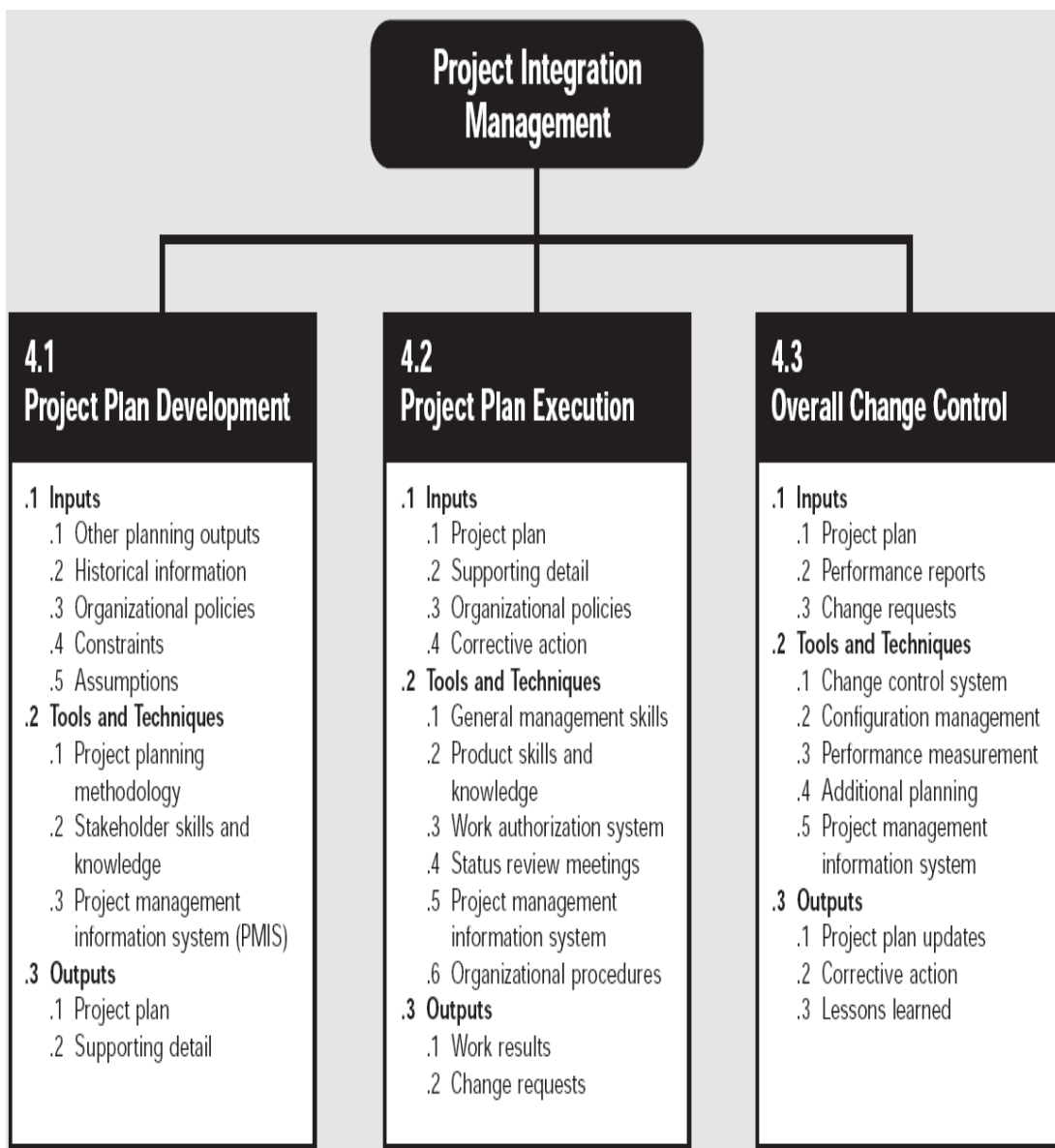
Figure 1–2. Overview of Construction Unique Project Management Knowledge Areas and Project Management Processes

PROJECT INTEGRATION AND SCOPE MANAGEMENT

PROJECT INTEGRATION MANAGEMENT

Project integration management includes the processes required to ensure that the various competing objectives and alternatives in order to meet or exceed stakeholder needs and expectations. The following are major processes of project integration management.

- i. Project plan development-taking the results other planning processes and putting them into a consistent, coherent document.
- ii. Project plan execution-carrying out the project plan by performing the activities included therein.
- iii. Overall change control-coordinating changes across the entire project.



Project Plan Development: project plan development uses the outputs of the other planning processes to create a consistent, coherent document that can be used to guide both project execution and project control. This process is iterated several times. The project plan is used to:

- Guide project execution
- Document Project planning assumption
- Document project planning decisions regarding alternatives chosen
- Facilitate communications among stake holders
- Define key management reviews as to content, extent and timing
- Provide a base line for progress measurement and project control

Project Plan execution: is the primary process for carrying out the plan. The vast majority of the project's budget will be expended in performing this process. In this process the project manager and the project management team must coordinate and direct the various technical and organizational interfaces that exist in the project. It is the project process that is most directly affected by the project application area in that the product is actually created there.

Overall change control: is concerned with;

- i. Influencing the factors which create changes to ensure that changes are beneficial.
- ii. Determining that a change has occurred
- iii. Managing the actual changes when and as they occur.

One of the most important aspects of plan execution in construction is the “control” of changes to the project. Changes may occur for a variety of reasons and from different participating areas of the project. It is the task of integrated change control to identify possible changes, review them for their effect on project scope, cost and schedule

Overall change control requires:

- a. Maintaining the integrity of the performance measurement base lines-all approved changes should be reflected in the project plan, but only project scope changes will affect the performance measurement base lines
- b. Ensuring that changes to the product scope are reflected in the definition of the project scope
- c. Coordinating changes across knowledge areas(example, a proposed schedule change will often affect cost, risk quality and staffing)

SCOPE MANAGEMENT

Scope management is defined as the process required to ensure that the project includes *all the work required and only the work required* to complete the project successfully. It is primarily concerned with defining and controlling what is or is not included in the project and develops the requirements set out in the project charter into workable sets of deliverables.

Effective management of project scope is one of key factors determining a project's success. Failure to accurately interpret the client's needs or problems results in misleading definition of the *scope of work*. If this causes rework or additional effort, there may be project cost and time implications.

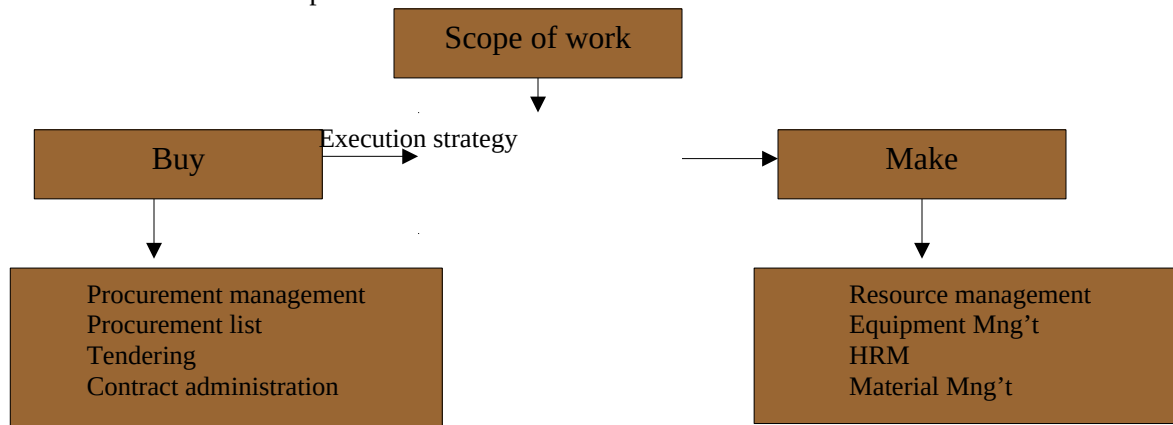
Scope management involves:

Scope planning: is a process of creating the project scope management plan that enables to define, verify, and control the project scope.

Scope definition: is the process of developing detailed project scope statement that enable to guide the project work. Normally, it demands sub-dividing the major project deliverables into smaller, more manageable components in a structured approach termed *product analysis*. The product analysis process enables to structurally and procedurally analyze the product and sub-divide it. Then, this is changed into activities/endeavors that needed to be executed to achieve the product. It is very essential to sub-divide bigger work packages into smaller ones so as to make more improved estimates and assign responsibilities. Thus, scope definition outlines the contents of a project, how the project will be approached and explains how an integrated execution of the scopes defined will address the project's objectives. In a nutshell, it presents the *build method* of the project and the *work breakdown structure* depicting the details of all activities to be executed to achieve the project's objective[s].

The build method outlines how the product will be assembled or implemented. This, as it is common in construction, is presented in the form of *drawings, specifications and statements of work*.

Execution strategy: The approach to a given project highly depends on the execution strategy that the client of the project is to adopt. Major factors depend on the client's decision to '*buy or make*'. If the services and goods needed for the project's work are to be purchased, as it is often the case in construction, the major activities to be dealt with, by the client, will be procurement issues. However, if the project is to be executed '*in house*' it will be a resource issue where the execution strategy should deal with the resource pool.



Work breakdown structure and scope definition

A very important tool in determining all the works that are required to achieve objective, hence scope definition is the work breakdown structure (WBS). A WBS is a deliverable-oriented hierarchical decomposition of the works to be executed by the project team to accomplish the project objectives and create the project deliverables. The major task in the creation of the WBS is the *systematic decomposition* of the overall job into smaller chunks which are easily manageable. . Thus the purpose of WBS is to divide the total project into small pieces, sometimes called *work packages or work activities*. Dividing the project into work packages makes it possible to prepare project schedules and cost estimates and to assign management and task responsibilities.

There are two types of WBS frameworks: One in **text indentation** as given below and the other in **graphical form** as shown in the structure provided at the end of this sub sections.

text indentation

1.0.0	A house project
1.1.0	Civil work
1.1.1	Sub structure
1.1.1.1	Clearing
1.1.1.2	Drudging
1.1.1.3	Excavation
1.1.1.4	Rebar fixing
1.1.1.5	Concert casting
1.1.2	Super structure
	1.1.2.1
1.2.0	Plumbing
1.2.1	Piping
1.2.2	Sewerage
1.3.0	Electrical
1.3.1	Wiring
1.3.2	Appliances

In its preparation, various techniques are employed in decomposing jobs into smaller chunks such as:

- By category of work as distinguished by materials such as concrete, timber, steel etc,
- By category of work as distinguished by craft or crew requirements (formworks slab, formwork footings)
- By category of work as distinguished by equipment requirements,
- By area of responsibility. Work items done by the general contractor and each of his sub-contractor should be separated,
- By distinct structural elements such as footings, walls, beams, columns and slabs, etc
- With regard to owner's breakdown of the work for bidding or payment purposes,
- With regard to contractor's breakdown for estimating and cost accounting purposes.

Level of divisions

It is generally advantageous to introduce an explicit *hierarchy* of work activities for the purpose of simplifying the presentation and development of a schedule. For example, the initial plan might define a single activity associated with "site clearance." Later, this single activity might be sub-divided into "re-locating utilities," "removing vegetation," "grading", etc. However, these activities could continue to be identified as sub-activities under the general activity of "site clearance." This hierarchical structure also facilitates the preparation of summary charts and reports in which detailed operations are combined into aggregate or "super"-activities.

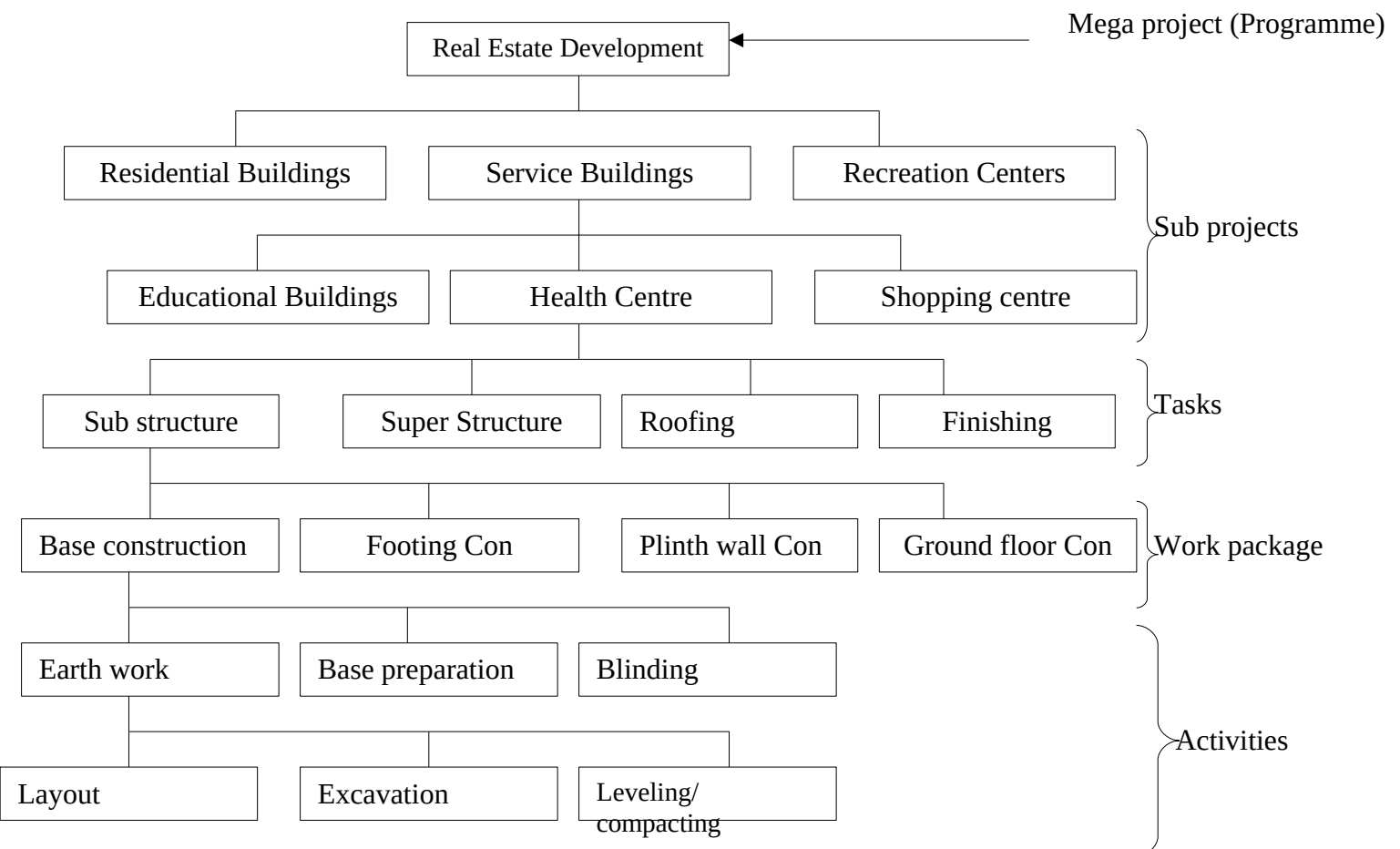
In practice, the proper level of detail will depend upon the size, importance and difficulty of the project as well as the specific scheduling and accounting procedures which are adopted. However, it is generally the case that most schedules are prepared with too little detail than too much. It is important to keep in mind that task definition will serve as the basis for scheduling, for communicating the construction plan and for construction monitoring. Completion of tasks will also often serve as a basis for progress payments from the owner. Thus, more detailed task definitions can be quite useful. But more detailed task breakdowns are only valuable to the extent that the resources required, durations and activity relationships are realistically estimated for each activity. Providing detailed work task breakdowns is not helpful without a commensurate effort to provide realistic resource requirement estimates.

As a general guide line, big projects can be sub-divided hierarchically as:

- Sub-project level: Sub projects are derived by dividing a large project, usually termed a *programme*, into independent large-volume mini projects.
- Task level: A task is an identifiable and deliverable major work which can be performed without major interference from other tasks.

- Work package level: A work package contains a sizeable, identifiable, measurable, costable and controllable package of work.
- Activity level: An activity is a sub division of a work package and is defined as a work which has a definite start and end and consumes resources.
- Operations level. Operations are sub-divisions of activities and generally are comprised of particular types and a fixed group of resources associated with it. The sum of resources consumed by operations equal the resources needed for the execution of the activity above it. Hence operation level planning forms the basis for allocation and scheduling of resources of each activity.

As a general guideline, construction projects are best programmed for day work by using operational level, best planned and monitored by using the activity level while best controlled by the work packages.



Scope verification: is the process of formally accepting the project deliverables. In the case of construction, such processes are usually drafted and carried out by supervising consultants in a view to check and approve that the works executed are in accordance to what is demanded in the deliverables. Usually such processes are carried out through inspection.

Scope control: is the process that is concerned with influencing those factors that could have resulted in scope change and containing its impacts. Generally, as a common practice in construction, scope control is carried out by performing organizations (contractors) while scope verifications are carried by consultants.

PROJECT TIME MANAGEMENT

Project time management includes all the processes that need to be adopted to ensure the timely completion of the project. It involved:

Activity definition is the processes of determining the specific activities that need to be executed to achieve objectives. Inherently related to the scope definition, activity definition produces all the list of activities that comprise the project work. It involves product analysis and takes further the WBS to come up with the lists.

Activities and related terms in common use:

An activity, as defined earlier, is an operation or process that consumes time for its completion, exception to this definition are dummy activities

Dummy activities are activities which have zero duration and consume no resource. They are introduced into a network diagram for a logical purpose. As will be discussed below, dummy activities will be present only on *activity on arrow network diagrams* to make sure that each and every activity is given a unique activity numbering, A_{ij}

Hammock or a summary of activity is bundle of activities used to gather a number of sub-activities into one master activity.

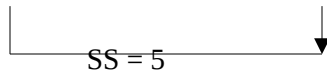
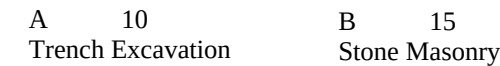
A *milestone* is a key event time when some decisive events happen. Example could be project completion day, meeting, delivery of specific critical output, phase transition, etc. Generally a milestone activity doesn't need resource and time. But in some cases, such as project handover, such activities may consumer a resource and time.

Activity sequencing is the processes of determining the job logic. It determines the dependencies, sequences and overlaps that activities need to be executed to achieve the project time constraint. Generally, activity sequencing and dependencies is determined by:

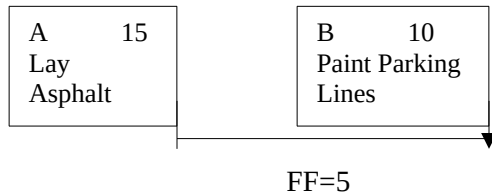
- **Mandatory requirements (hard logic):** are dependencies that are inherent to the nature of the project work. For example, one can't execute foundation concrete casting without having excavating the pits for foundation;
- **Discretionary requirements (preferred (soft) logic):** are dependencies established based on factors such as resource availability, familiarity with the processes, etc. For example, walling works in first floor can b executed parallel with structural works on fourth floor, as long as there is enough resource is available. Therefore, a dependency that puts start of walling work after finish of structural work is simply a discretionary requirement meant for resource or convenience reasons.
- **External requirements:** are dependency requirements that link project works with non project works. For example, getting a construction license may be an external dependency to most construction work. Nonetheless, it affects the work and hence has to be incorporated in the job logic outside the sphere of influence of the project activities.

These dependencies result in four different relationship types:

1.1 Start-to-Start (SS): *The start of the subsequent activity is some relationship dependent on the start of its predecessor. The relationship can be established based on lead or lag time. In the example below, start of activity B lag five days after start of activity A.*



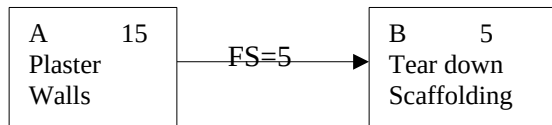
Finish-to-Finish (FF): The finish of the subsequent activity is some relationship dependent on the finish of its predecessor.



Start-to-Finish (SF): The finish of the subsequent activity is some relationship dependent on the start of its predecessor.



Finish-to-Start (FS): The start of the subsequent activity is some relationship dependent on the finish of its predecessor.



Activity duration Estimating: All formal scheduling procedures rely upon estimates of the durations of the various project activities as well as the definitions of the predecessor relationships among tasks. An activity's duration is dependent on the amount of job to be done, amount and productivity of resource to be deployed.

$$D_{ij} = \frac{A_{ij}}{P_{ij} N_{ij}}$$

Where A_{ij} is the amount of work to be done (eg 100 cubic meter of common excavation), P_{ij} is the average productivity of a standard crew in this task (measured in units of work per unit time), and N_{ij} is the number of crews assigned to the task

The following important rules apply to the estimation of activity durations:

- i) Evaluate activities one at a time, independently of all others. For a given activity, assume that materials, labor, equipment and other needs will be available when required,
- ii) For each activity assume a normal level of manpower and/or equipment. Compute the estimate duration by applying a crew or equipment production rate to the total number of units of work to be done. It is highly advisable to use the optimum resource needed for the execution of the activity. Ex. Activity duration to pour 230 m² of slab formwork, assuming a production rate of 1.5 m²/hr /crew can be established as follows

$$\begin{aligned} \text{Duration} &= \text{quantity/productivity} \\ &= 230 \text{ m}^2 / 12 \text{ m}^2/\text{day} = 17.5 \text{ days} \end{aligned}$$

- iii) If time units of working days are being used, assume a normal working day. Do not consider overtime or multiple shifts unless this is a usual procedure or a part of the standard work day.
- iv) Be advised that productivity follows a learning curve whereby it is low near the start to the task until adjustments, goes with best productivity for some time and as the work is to be finished, productivity reduces.

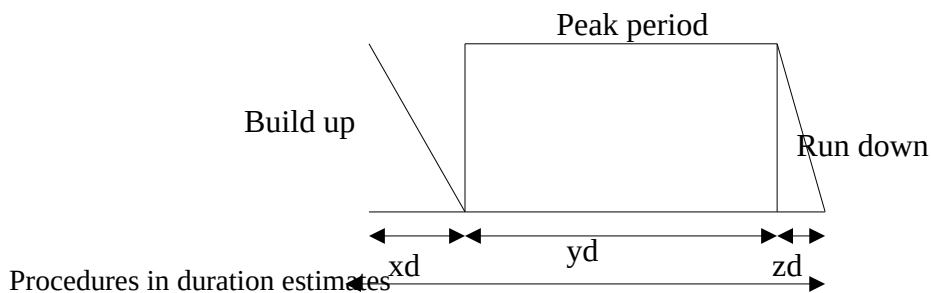
Duration Estimation Methods: There are about three activity duration estimation techniques employed in projects:

One-time estimate: This is a single average estimate of time required for the completion of the activity. It is usually based on past experience on execution of a similar project or average time assessed by a group of executives.

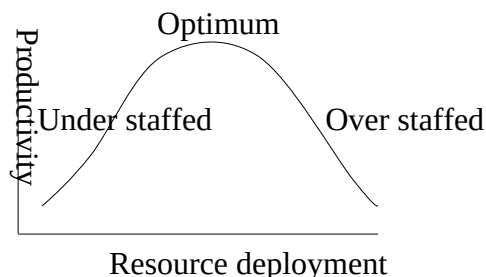
Three-time estimate: The three time estimate method, often used in projects not familiar, uses three estimates as in optimistic time (T_o) which assumes everything goes according to plan, most likely time (T_m) that assumes normal condition and a pessimistic estimate (T_p) which envisages most things may go wrong. Thus, the expected time of completion (T_e)

$$T_e = \frac{T_o + 4T_m + T_p}{6}$$

Trapezoidal distribution estimate: The one time estimate discussed above assumes average uniform productivity throughout the executing of a given activity. The trapezoidal distribution estimate takes into account a leaner learning curve as build up to a pick productivity followed by sustained pick productivity and then a rundown in productivity as things windup to completion.



- Estimate the quantity of work to be done
- Decide the labor, equipment and material constants (unit productivity)
- Assess the optimum resource deployment:



- Estimate the activity completion period

$$\text{Completion period} = \frac{\text{Quantity of work}}{\text{Unit productivity} \times \text{Resource earmarked}}$$

- Use three-time or non-linear estimates where it is not possible to predict reasonable activity duration by one time method.

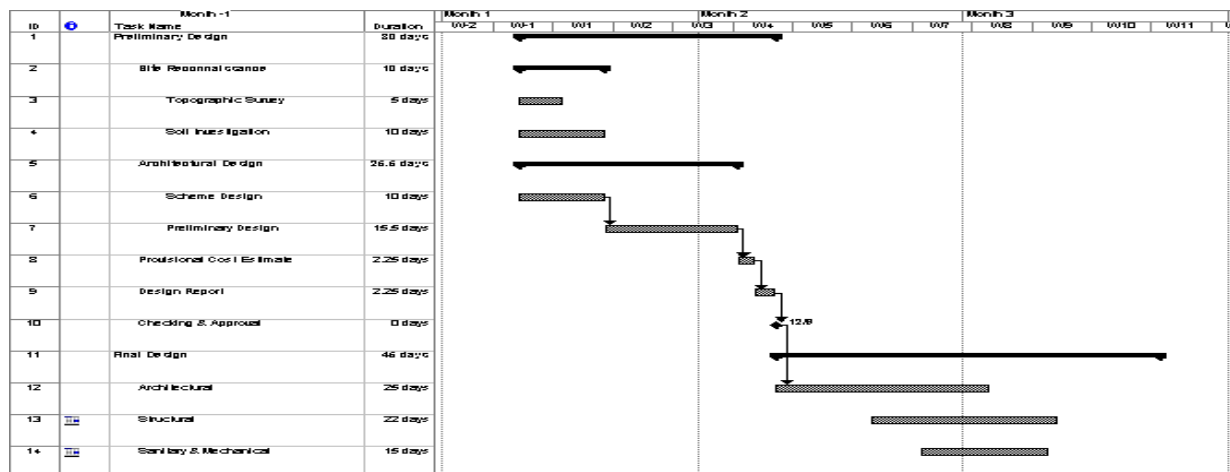
Schedule development: is the process that executes the interactions fixed in sequencing and the durations determined above to establish the start and finish time of each and every activity and the overall project. A variety of scheduling techniques are available of which only three are to be outlined indicating the advantages and disadvantages and the most application in practice.

- The Bar Charts
- Line of Balance Chart
- The Networking Schedule Technique
 - ✚ The Critical Path Method (CPM),
 - ✚ The Performance Evaluation & Review Technique (PERT)
 - ✚ Critical Chain Method

Bar chart

Bar charts present the project schedule plotted to a horizontal line scale. The bar lines represent the time period allocated to each operation and the relationship between the commencement and completion of each can be readily observed. The bar chart has been the traditional management device for planning and scheduling construction projects. Bar charts are particularly helpful for communicating the current state and schedule of activities on a project. As such, they have found wide acceptance as a project representation tool in the field. There have been various schemes for mechanically linking activity bars to represent precedence, but it is now easier to use computer based tools to represent such relationships.

Example of schedule using bar chart:



Advantages of Bar chart:

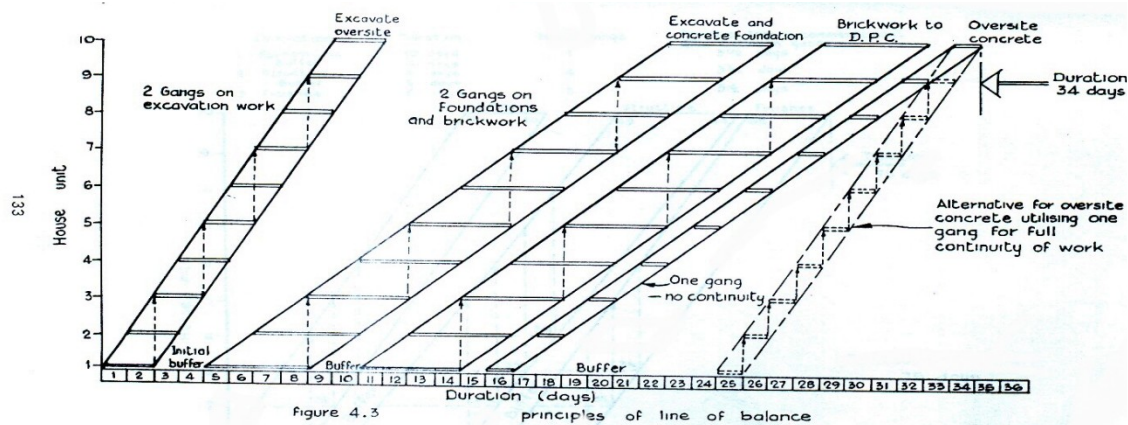
- ✚ Useful to report information to people who are concerned about a project but may not be involved in day-to-day management.
- ✚ A simple format and readily understood at all levels of management,
- ✚ It can provide a quick, visual overview of a project in convenient way to monitor job progresses, schedule equipment and crews and record project advancement.

Disadvantages:

- ✚ Interdependencies among activities are difficult to show. The bar chart itself doesn't provide a basis for ascertaining which activities are critical and which are floaters.
- ✚ It is not an adequate planning and scheduling tool because it doesn't portray a detailed, integrated and complete plan of operations.

The Line of Balance Scheduling Technique

The Line of Balance schedules are a series of inclined bar lines, one for each activity. The difference between Line of Balance Schedules and a traditional bar chart is the balance lines are inclined at different slopes to denote the rate of working of the various operations.



In developing the schedule, one is required to determine the number of crew to be availed for each activity with the productivity rate on daily basis. The respective activities will be indicated with an inclined bar on a diagram scaled contract time versus project units or segments subdivided for planning purposes. If the bars intersect on the diagram, this will be a clear indication that resource has not been properly allocated. Intersection of the bars shows that the crew assigned for a particular activity would stay idle until the preceding activity is progressed a bit far from the following activity.

Application:

The planning system is suitable for housing contract, roads construction, pipe laying work and the erection of prefabricated buildings of repetitive nature. The process may be applied to any sequence involving the coordination of a number of repetitive activities.

Advantages of the Line of Balance scheduling:

- ✚ Clearly displays the rate of working of one activity against another,
- ✚ Relates the requirement of specified resources to the achievement of a planned completion date,
- ✚ The schedule clearly indicates the number of units to be completed by a specific date,
- ✚ The principles of planning system are readily understood at site management level. The schedule is easily updated. Actual performance can be compared with planned requirements at any date.

Disadvantages:

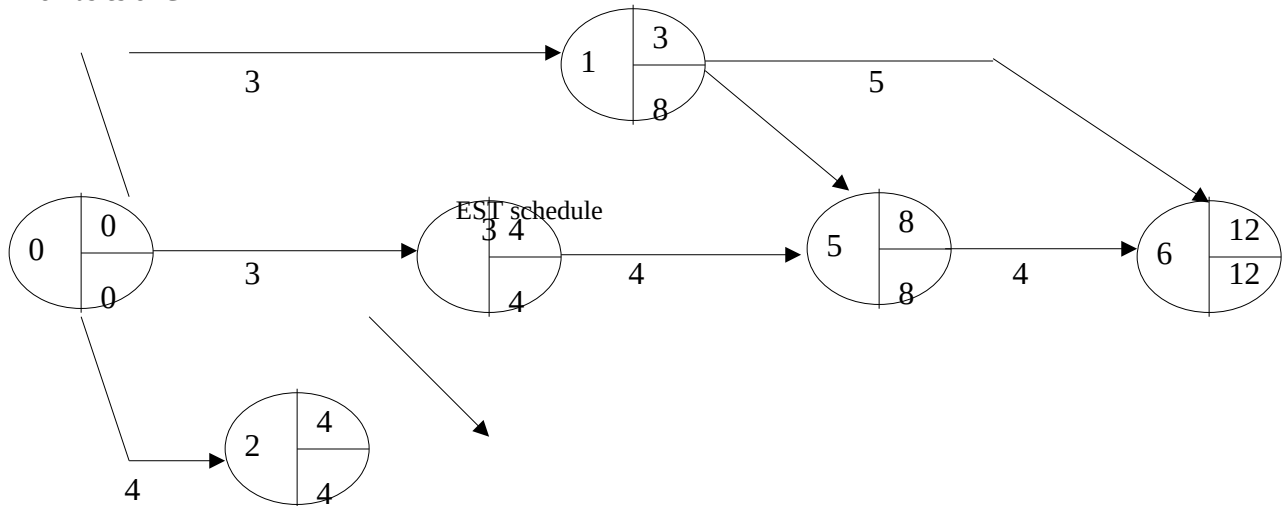
- ✚ Only applicable to repetitive forms of construction,
- ✚ Summarizes many considerations, this short of detail and hence explanations.

The Networking Schedule Technique

The Critical Path Method (CPM)

The most widely used scheduling technique is the critical path method (CPM) for scheduling, often referred to as *critical path scheduling*. This method calculates the minimum completion time for a project along with the possible start and finish times for the project activities. Indeed, many texts and managers regard critical path scheduling as the only usable and practical scheduling procedure. Computer programs and algorithms for critical path scheduling are widely available and can efficiently handle projects with thousands of activities.

The Basics of CPM

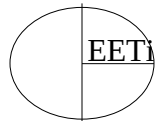


The basic elements of a network analysis are activity and event.

An *event* is a point in time. It usually represents completion of a preceding activity and beginning of succeeding one. An event has no duration.

Event timing and associated terms

Earliest Event Time (EET) is the earliest time that an event can take place.



The EET of the first event, which usually is the start of the project itself, is taken zero while the EET of the subsequent event is calculated by adding the activity duration to it. If there are more than one activities leading to an event, the EET of that event will be the highest value obtained by adding activity durations to the EETs of the preceding events. Such process of determining EET by adding activity durations onto EETs of previous events is known as *forward pass*, adopted from the process of moving forward from preceding to subsequent events

Latest Event Time (LET) is the latest time that an event can occur without affecting the on time completion of the project. According to this definition, and unless otherwise specified so, the LET of the end event, such as completion of project, is taken to be equal to its EET. Thus the LETs of the remaining events are calculated by moving in a reverse path, hence termed *backward pass*, and subtracting the activity duration from the LET of the event the activity leads to. If more than one activity diverges from an event, then its LET would be the lowest value obtained by subtracting the duration of each activity from the LET of the respective succeeding events

Activity timing and associated terms:



Earliest Start Time (EST) is the earliest time an activity can start assuming that all activities leading to this specific activity have taken place as early as possible.

$$EST_{ij} = EET_i$$

Earliest Finish Time (EFT) is the earliest time that an activity can be completed.

$$EFT_{ij} = EST_{ij} + d_{ij}$$

Latest Start Time (LST) is the latest time an activity can start without pushing the overall project beyond its stipulated completion time.

$$LST_{ij} = LET_j - d_{ij}$$

Latest Finish Time (LFT) is the latest time that an activity must be completed to ensure on time project completion.

$$LFT_{ij} = LET_j$$

Total Float (TF) is the maximum period of time that the earliest start of an activity can be floated without leading into overall project delay. Total float is the difference between LST and EST of a given activity.

$$TF_{ij} = LST_{ij} - EST_{ij} = LET_j - EET_i - d_{ij}$$

Free Float (FF) is the maximum period of time that the earliest start time of a given activity can be delayed without affecting the earliest start time of the subsequent activity.

$$FF_{ij} = EST_{jk} - d_{ij} - EST_{ij} = EET_j - d_{ij} - EET_i$$

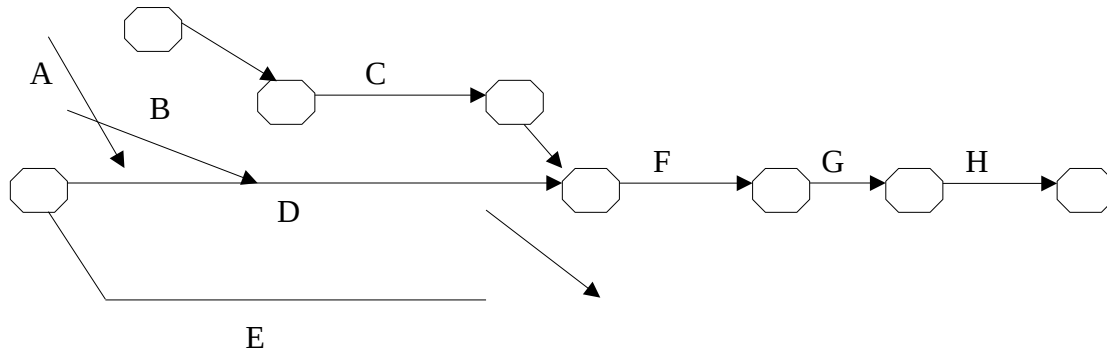
Critical activities are activities in the network diagram that have zero total floats.

The *critical path* itself represents the set or sequence of predecessor/successor activities which will take the longest time to complete. The duration of the critical path is the sum of the activities' durations along the path. Thus, the critical path can be defined as the longest possible path through the "network" of project activities. The duration of the critical path represents the minimum time required to complete a project. Any delays along the critical path would imply that additional time would be required to complete the project. Formally, critical path scheduling assumes that a project has been divided into activities of fixed duration and well defined predecessor relationships. A predecessor relationship implies that one activity must come before another in the schedule. No resource constraints other than those implied by precedence relationships are recognized in the simplest form of critical path scheduling.

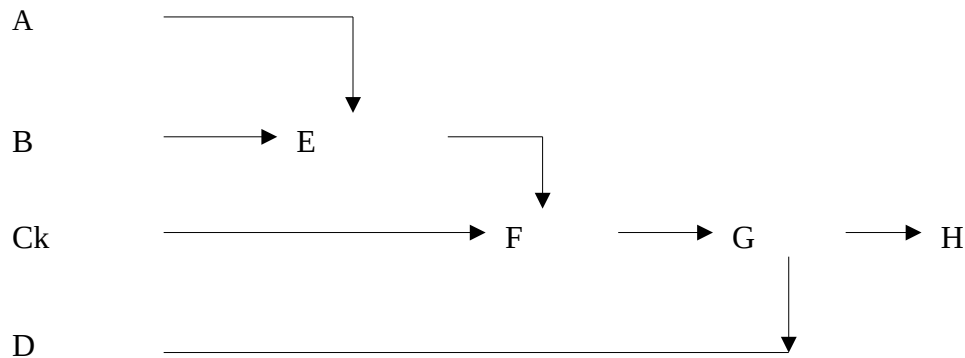
Si No	Activity	Duration	Event timings			Activity timings				Floats		Sensitivity ranking
			EET _i	EET _j	LET _j	EST _{ij}	EFT _{ij}	LST _{ij}	LFT _{ij}	TF	FF	
1	0-1	3	0	3	7	0	3	4	7	4	0	
2	0-3	3	0	4	4	0	3	1	4	3	1	
3	0-2	4	0	4	4	0	4	0	4	0	0	
4	2-3	0	4	4	4	4	4	4	4	0	0	
5	1-5	0	3	8	8	3	3	8	8	5	5	
5	3-5	4	4	8	8	4	8	4	8	4	0	
6	1-6	5	3	12	12	3	8	7	12	4	4	
7	5-6	4	8	12	12	8	12	8	12	0	0	

Forms of network diagram

Network scheduling can take two forms: Activity on arrow notation or activity on node notation.



Activity on arrow notation (AOA)



Activity on node notation (AON)

Important features of a network diagram:

- The arrow notation in the first diagram or the rectangular nodes in the second denote activities.
- The arrow notation in second diagram shows the precedence existing among the activities,
- The circular nodes in the first diagram designate activity events. All arrows must start and finish at this nodes. An event might describe as that instant of time when the latest finishing activity coming into that node has just been completed.
- Critical path is a path in the network, when the duration is summed up, provides the project completion time. Any lag on the starting or finishing time of these activities will be directly reflected as delay on the project completion period.
- Dummy activities are normally are used only in AOA diagram and are indicated with hidden arrow in a network and are not an indication of an activity but a logical connection between activities.
- Floating time is the time in which the starting and finishing time of an activity can be shifted without affecting the completion period of the project. Activities along the critical path have no floating time.
- Usually in AON diagram a 'Lag time' is used to show a period of time between finish of a preceding activity and start of its successor. Eg. A 7 day lag time for curing concrete

The Precedence Diagramming Method (PDM)

The network scheduling system in the CPM using the above AOA or AON methods assumes a strict sequential relationship upon which the start of an activity is predicated upon the completion of its immediate predecessors. This strict “start” only when the predecessors are finished relationship is called Finish to Start (FS). The limitation of the FS network representation is that it precludes those kinds of tasks that can be started when their predecessors are only partially completed, or at least such activities must be broken down to make cater for the logic. For example, when a building foundation is being constructed, “stone masonry work” activity can start as soon as some of the trench excavation has been accomplished. Although it might be necessary to have completed “trench excavation” before starting “stone masonry works”, the point is that “stone masonry work” can begin before its immediate predecessor “trench excavation” has been completed. The Precedence Diagram Method (PDM) allows for this and other situations. Besides the usual FS relationship, PDM permits the relationships of Start-to-Start (SS), Finish-to-Finish (FF), and Start-to-Finish (SF). It also allows for time lags in these relationships, such as lags between two starts, two finishes or a start and a finish.

There is a special kind of CPM that allows for such relationships. It is named a *precedence diagrams method*. It uses the AON scheduling techniques and is the most used form of CPM in computer applications.

Time (schedule) monitoring and control: are processes concerned with tracking the project progress, anticipating and influencing factors that may lead to schedule change, update the schedules and manage the changes when they occur. Such tools as EVA techniques can be used in monitoring and evaluations.

Program Evaluation & Review Technique (PERT)

The two commonly used network methods for project planning and scheduling are the program evaluation and review technique (PERT) and the critical path method (CPM). Both PERT and CPM are termed critical path methods because both use the critical path to complete expected project duration, early and late times, and slack. The two are frequently described under one term, PERT/CPM. Despite their similarities, PERT and CPM were developed independently in different problem environments and industries.

PERT was developed for application in projects where there is uncertainty associated with the nature and duration of activities. It originated in the late 1950s during the U.S. Navy’s Polaris Missile System Program. In complex research and development programs, there are questions about the kind of research to be done, how long it will take, what stages of development are necessary, and how fast they can be completed- largely because of the uncertainty about the exact nature of the final outcomes. Such projects are contracted as new developments unfold and before problems in technology, materials, and processes can be identified and resolved. Thus, the duration of the project is uncertain and there is considerable risk that the project will overrun the target completion time. Therefore, unlike the CPM, which uses a deterministic time estimate, PERT uses a *probabilistic time estimate*.

Critical chain method

Critical chain method of project scheduling an out growth to the theory of constraints. Unlike CPM and PERT, the Critical Chain project network will tend to keep the resources levelly loaded, but will require them to be flexible in their start times and to quickly switch between tasks and task chains to keep the whole project on schedule.

Planning

A project plan is created in much the same fashion as with critical path. The plan is worked backward from a completion date with each task starting as late as possible. Two durations are entered for each task: a "best guess," or 50% probability duration, and a "safe" duration, which should have higher probability of completion (perhaps 90% or 95%, depending on the amount of risk that the organization can accept).

Resources are then assigned to each task, and the plan is resource leveled using the 50% estimates. The longest sequence of resource-leveled tasks that lead from beginning to end of the project is then identified as the critical chain. The justification for using the 50% estimates is that half of the tasks will finish early and half will finish late, so that the variance over the course of the project should be zero.

Recognizing that tasks are more likely to take more rather than less time due to for various reasons, "buffers" are used to establish dates for deliverables and for monitoring project schedule and financial performance. The "extra" duration of each task on the critical chain—the difference between the "safe" durations and the 50% durations—is gathered together in a buffer at the end of the project. In the same way, buffers are gathered at the end of each sequence of tasks that feed into the critical chain.

Finally, a baseline is established, which enables financial monitoring of the project.

Execution

When the plan is complete and the project ready to kick off, the project network is fixed and the buffers size is "locked" (i.e. their planned duration may not be altered during the project), because they are used to monitor project schedule and financial performance.

With no slack in the duration of individual tasks, the resources on the critical chain are exploited by ensuring that they work on the critical chain task and nothing else; bad multitasking is eliminated. An analogy is drawn in the literature with a relay race. The critical chain is the race, and the resources on the critical chain are the runners. When they are running their "leg" of the project, they should be focused on completing the assigned task as quickly as possible, with no distractions or multitasking. In some case studies, actual batons are reportedly hung by the desks of people when they are working on critical chain tasks so that others know not to interrupt. The goal, here, is to overcome the tendency to delay work or to do extra work when there seems to be time.

Because task durations have been planned at the 50% probability duration, there is pressure on the resources to complete critical chain tasks as quickly as possible, overcoming student's syndrome and Parkinson's Law.

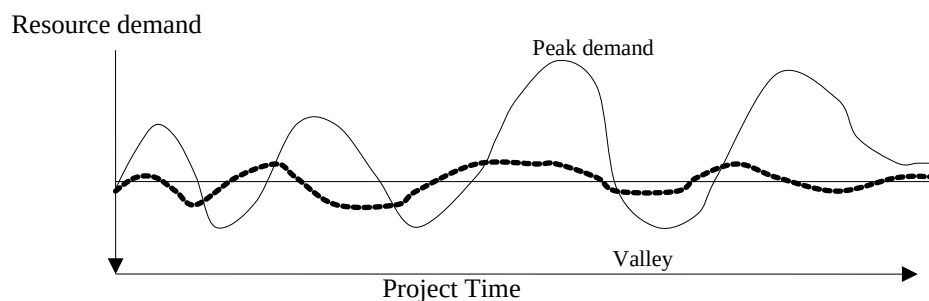
Monitoring

Monitoring is, in some ways, the greatest advantage of the Critical Chain method. Because individual tasks will vary in duration from the 50% estimate, there is no point in trying to force every task to complete "on time;" estimates can never be perfect. Instead, we monitor the buffers that were created during the planning stage. A fever chart or similar graph can be easily created and posted to show the consumption of buffer as a function of project completion. If the rate of buffer consumption is low, the project is on target. If the rate of consumption is such that there is likely to be little or no buffer at the end of the project, then corrective actions or recovery plans must be developed to recover the loss. When the buffer consumption rate exceeds some critical value (roughly: the rate where all of the buffer may be expected to be consumed *before* the end of the project, resulting in late completion), then those alternative plans need to be implemented.

RESOURCE PLANNING AND RESOURCE-LOADED NETWORK DIAGRAMS

As discussed earlier, there is a trade-off between resource requirement for an activity and the duration required to execute the activity. Though, network analysis techniques assume that there is optimum usage of resources, it may be necessary, for various reasons, to smoothen sharply contrasting resource requirements of a project by maneuvering within the *floats* of activities.

The concept of *float* is to use part or all of the allowable range to schedule an activity without delaying the completion of the project. An activity that has the earliest time for its predecessor and successor nodes differing by more than its duration possesses a window in which it can be scheduled. This rescheduling of floating activities is helpful for resource leveling / smoothening/. It is often advisable to avoid peaks and valleys of resource deployment on site and maintain relatively smoothened or flattened resource delivery from practical considerations.



Resource schedule as planned with earliest start



Smoothened manpower demand

To facilitate the smoothening process, it is very helpful to prepare a *resource-loaded diagram* for the most important resources to be used in the execution of the project using the early start times. Then, using the floats available for activities, the most important (expensive) resources can be leveled:

NB:

- ✓ Resource smoothening is usually done for the most important [expensive] resource. It is practically impossible to level all the resources as that may lead to a spiral circle. Thus project managers have to decide for which resource to tailor their project. Suggested guidelines could be to smoothen for:
 - i. The most expensive resource
 - ii. The resource that is most overloaded
 - iii. The least flexible resource etc.
- ✓ When you level for one resource, be careful to accordingly arrange the associated resources for that specific resource. Eg. Leveling for loaders may need re-arrangement of the dump trucks as well.
- ✓ Unlike carpenters in the above example, who can easily be moved from one activity to another, there are some resources that need *lead time*. Eg. A crane in use in one position may need to be dismantled and re-assembled at another position for use. Hence, the scheduling and smoothening process should take care of this fact.
- ✓ Be ware that floats used in the early phases of the project render the remaining activities critical.
- ✓ While resource smoothening is very important tool in reducing expenses, it is very important to bear in mind that rate productivity may decrease as the smoothened combination of resources may not be the optimum combinations
- ✓ Aside from moving activities within floats, changing the logic of activities can also help in reducing the amount of resources needed to execute a project.

TIME-LIMITED VS RESOURCE-LIMITED SCHEDULING

As discussed above, there may arise a case that a project has to satisfy a strictly defined end date for such reasons as the project has a heavy time penalties, the project is part of another project with critical access dates, the completion on time of the project is very crucial such as Olympic stadium for the games in such cases, project managers may need to crash activities to meet the completion deadline rather than use the optimum trade-off between time and resource. Such type of project which are very time sensitive are said to be scheduled *on time limited scheduling* techniques.

Ways of meeting deadlines other than crashing:

- ✓ Working overtime;
- ✓ Working on shifts;
- ✓ Increasing productivity by training, applying appropriate motivational factors such as 'job and knock' principles;
- ✓ Sub-contracting. If there are some special sub-contractors who are veteran in the trade to be executed, sub-contracting the job to them may save time as they have the best experience in doing the job and can do it in a lesser time.

PROJECT COST MANAGEMENT

The financial success of a project depends not only on the product of the project making a profit, but also the project financing itself through the project life cycle. For this though, project managers need a clear and effective cost management approach to their projects.

Project cost management involves all the processes needed in planning, estimating budgeting and controlling of costs so that the project is finished within budget. It generally involves:

Cost estimation: is an integral part of a project management endeavor. It combines *the WBS, the project schedules, procurement schedules and resource histograms*.

Predominately based on the quality of information available and the effort put into compiling the estimate, project estimates can be classified as:

- **Conceptual estimates:** also called order of magnitude, budget figure, ball-pack figure or thumb suck is a rough estimating technique which depends on rough scope of work. Conceptual estimates usually used to filter projects that may warrant further investigation.
- **Feasibility estimate:** also called preliminary estimate or comparative estimate, are project estimate made along with the feasibility study. It generally is expected to produce +/- 10% accuracy.
- **Definitive estimate:** also referred to as detailed estimate, project control estimate, quotation or tender is the estimate that will be conducted after having the design and planning information. It is based on scope of work, resource deployment and resource rates. Generally, such estimates are rolled up after having costing of each activity that comprise the project's work plus *contingencies*. An activity's costs includes the *direct costs* incurred in executing the activity, share of the *indirect cost* associated with the project, share of the *overhead cost* of the firm and the share of the *profit*. Moreover, such estimates should consider time related costs such as *inflations and scale related factors* such as, [dis]economies of scale, specialization, indivisibility, etc.

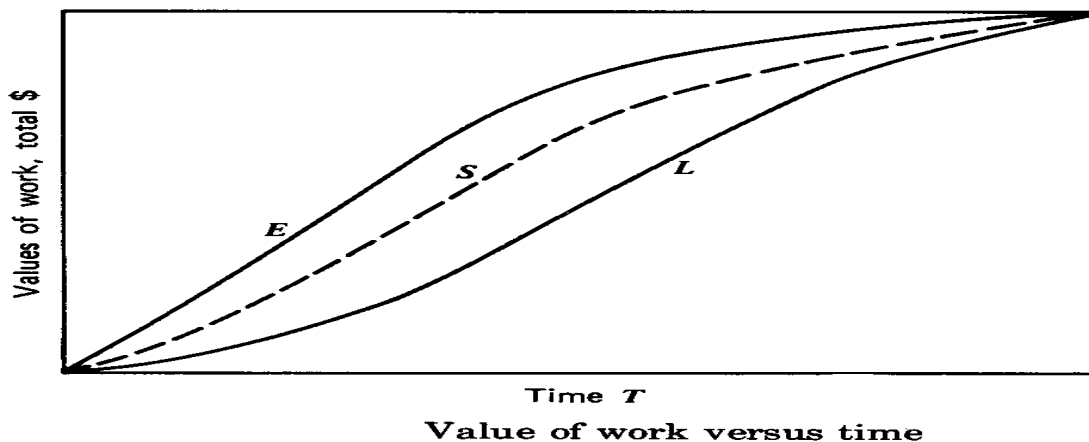
If a project manager clearly stipulates all the resources necessary to execute all the activities in his [her] WBS of project plan, [s]he can determine the cost of each activity fairly easily by adding the indirect cost [overhead, profit etc] proportion of the specific activities. By loading this to the schedule of the project, the project manager will have a *cost-loaded diagram*.

A cost-loaded diagram provides various advantages for the project manager.

- ✓ Provides an easy start point for the preparation of the cash-flow diagram which is the fundamental tool for budgeting;
- ✓ Helps reduce amount of subjectivity in pay requests during execution of the project. Pay requests to each activity executed [or its percentage] can be tailored to the amount allocated for;
- ✓ Helps to identify and rectify problems arising by *front-end loading* and incorrect billing by contractors. As each activity is costed and the cost shown, the tender evaluators can easily recognize whether the early activities are overly priced or not;
- ✓ Facilitates decisions whether to *crash* or not;

Cash flow diagrams

Once a cost-loaded diagram is prepared for a given project, the cumulative spending during the life cycle of the project can easily be plotted against the project period to get the *cumulative cash flow diagram* over the project period. The resulting curve, often referred as S curve due to its shape, is one of the fundamental tools used in budgeting for projects.



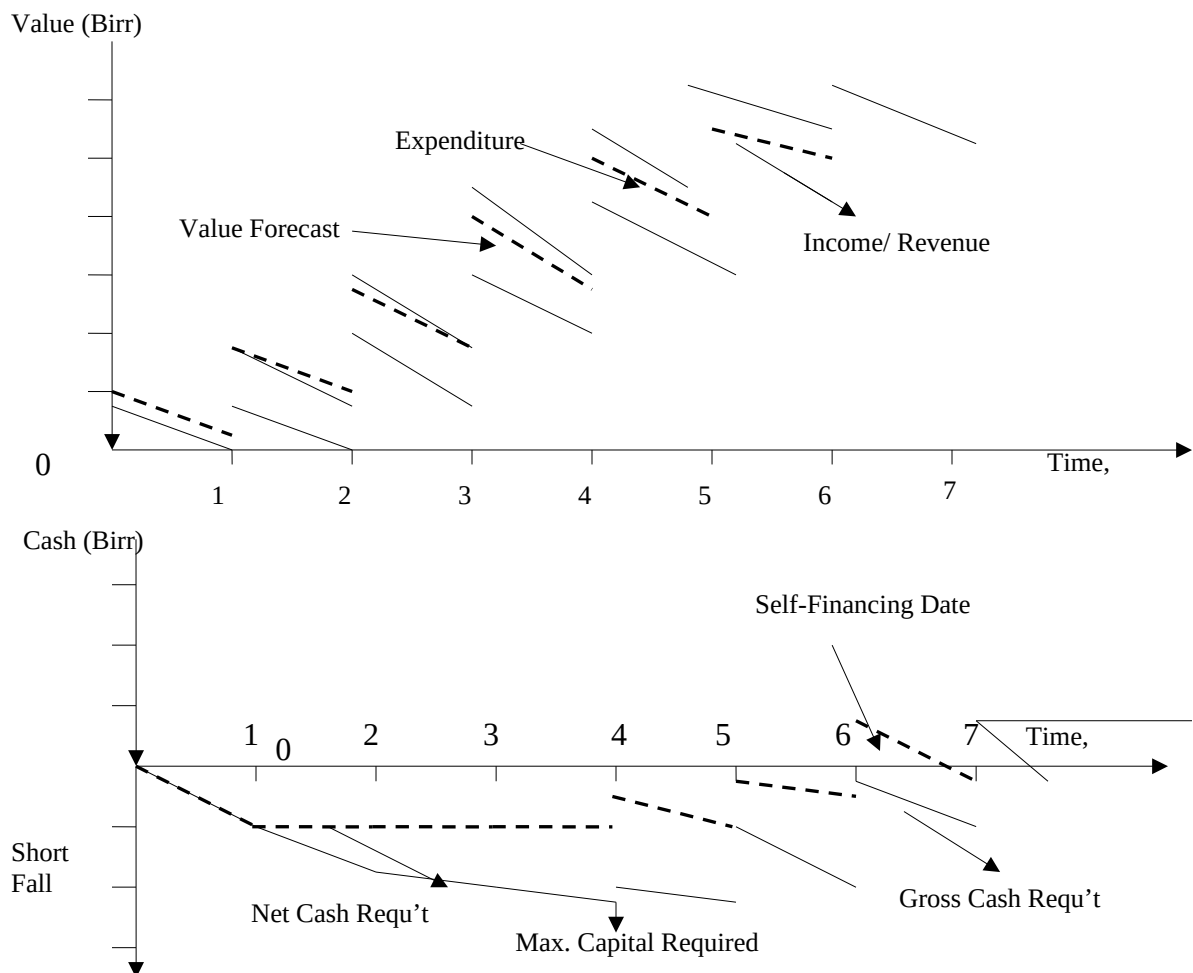
With a reasonable network plan and realistic estimated activities duration time, a good schedule plan, then, must lie between the two limits defined by (a) every activity starting at its earliest possible time, and (b) every activity starting at its latest possible time.

The figure above shows these limits plotted as cumulative expenditures versus time. The curve is commonly known as an S-curve. Curve E shows cumulative expenditures versus earliest starting times. Curve L shows cumulative expenditures versus latest starting times. An examination of curve E shows a very high rate of expenditure at the beginning of the project, whereas curve L indicates a very high rate of expenditure during the later part of the project. Both E and L schedule plans are unrealistic. From the owner's point of view, curve E has a disadvantage in that his capital is tied up over a longer period of time, resulting in substantially higher interest cost. The other critical disadvantage is that the owner has little time to incorporate changes without suffering an increase in cost. The major disadvantage of curve L is that by delaying all activities for as long as possible, the project schedule loses its safety margins, and as a result unexpected conditions may arise that will make non critical activities critical and delay the project. In addition, neither curve minimizes the extreme rises and falls in the man power requirements during the life of the project.

To determine a desirable schedule plan S that will minimize the fluctuations in the labor force throughout the project and provide flexibility in the schedule plan to meet unexpected conditions, the planner must consider not only manpower and project cash flow requirements but also local project conditions.

At this point, project managers need to be cautious of the *accrual* of costs over activity duration of execution. For example, labor costs are generally assumed to be uniform over the duration of activities while material costs or other bought in items may generally be qualified before the onset of activity or even with some lead time or can even be paid later if some credit arrangement is possible. Thus, the accrual of costs over activities as *front in loading*, *linear distribution*, *end of activity loading* or even *credit arrangements* need to be considered in drafting a cash flow diagram that is to be used properly for budgeting and proper payment purpose.

Income Forecast. Project works do generate incomes. The advanced payments, interim payments, etc. The revenue to be collected from the project on monthly basis equates from the cumulative value minus the retention money, previous payments and other deductions such as advance payments. Income forecast is the contractor's revenue to be collected from the client through successive payment certificates. As it is crucial for the project to finance the work, it is fundamental that the incomes are forecasted and the net cash requirements are set in advance and possible ways of filling the deficits should be sought.



Cost control: includes all the processes that are needed to account for and influence factors that could lead to cost change, monitoring cost performance to detect potential drifts, manage cost changes when

they occur, etc. Such processes are normally effected through tracking costs to check expenditures, evaluating and forecasting potential changes and effects, and reporting them. The EVA technique discussed in chapter three is an important tool in evaluating and forecasting. However, the output is only as good as the input data and the appropriate tracking of costs and changes. Indeed the major challenge in proper utilization of the EVA is lack of accurate and suitable data. More specifically, reports are often reported too optimistic in the early phases (usually due the fact that people don't want to report negatives that may render them incompetent). However, this may have spiraling negative implications in the later stages.

1.2 Cost-Time Trade-off and Project Crashing

In preparing the EST baseline schedule, we assumed an optimum resource level deployed to execute a certain activity. Though, this could be the 'best' trade-off between time and cost, sometimes it may be necessary to execute activities faster than the optimum time required, as usually is the case in catching up when project lag behind or when clients demand expedient finish of project for business or otherwise decisions. Such expedient execution of activities [projects] is termed as *crashing* and is bound to require additional resources. These resources might be additional labor, more equipment, and so on. Although shortening or "crashing" activity times can be expensive, doing so might be worthwhile. If a company faces costly penalties for being late with a project, using additional resources to complete the project on time might be economical. There may be fixed costs every day the project is in process. Thus, it might be profitable to use additional resources to shorten the project time and save some of the daily fixed costs. But what activities should be shortened? How much will this action cost? Will a reduction in the activity time in turn reduce the time needed to complete the entire project? Ideally, project managers would like to find the least expensive method of shortening the entire project.

The objective of crashing is to reduce the entire project completion time by a certain amount at the least cost possible. For each activity, there will exist a reduction in activity time and an associated cost incurred for that time reduction. However, for practicality purpose, there exists some minimum time period that an activity requires for execution irrespective of the resource amount deployed. Hence activity durations can't be reduced indefinitely. Moreover, it has to be noted that costs may not flow a linear relation with time shortening or elongation. However, here, for simplicity, we will assume that costs increase linearly as the activity time is reduced from its expected to its crash value.

Let: Normal time = expected time for an activity
 Crash time = shortest possible time for that activity
 Normal cost = cost of completing the activity in normal time
 Crash cost = cost of completing the activity in the crash time

$$\text{Crash cost per unit time} = \frac{\text{Crash cost}}{\text{time period}} = \frac{\text{Crash cost} - \text{Normal cost}}{\text{Normal time} - \text{Crash time}}$$

In its simplistic form quality can be defined as ‘the degree to which a set of inherent characteristics of a certain construct fulfills requirements’. Thus the major feature of quality is fitness to requirements.

Therefore, project quality management is the process of determining quality policies, standards, objectives, responsibilities, etc so that the project fulfils the purpose it is undertaken for.

It generally involves:

Quality planning: where quality standards that suite the project are identified and ways of fulfilling them is depicted. In the case of construction, such a process usually is presented in the form of technical specifications, drawings, manuals, etc that are compiled with through analysis of the projects purpose.

Quality assurance: is the process of applying the quality criteria set out in the planning face and ensure that the project employs all the processes needed to meet requirements. Its major purpose is to ensure that the project and its product satisfy the purpose it is undertaken.

Quality control: is a process of monitoring executions and products in order to determine if they satisfy relevant quality standards, and if they don’t see into the causes of the deviations and their effects.

The common practice in construction is that, project supervisors inspect projects as a quality control mechanism while performing organizations (contractors) are said to make sure that what they do satisfies quality requirements-hence perform quality assurance. However, in recent times, it is generally accepted that one **can’t inspect quality into a product**. Hence, there are major calls for a shift in paradigm that focuses in assuring quality in the first place rather than having to control it.

Quality and grade

Quality is distinct from grade (class). A grade is a category assigned to a product with different technical specifications. For example, ERA’s trunk (class I) roads are usually designed using DS1 which puts a more stringent specification as compared to rural roads (class VI) which normally is designed using DS6. Thus the trunk roads and the RR50’s have different grade. A low grade may not be a problem, as long as it satisfies its purpose and requirement while a low quality is always a problem. A low quality RR50 road withers out without fulfilling the life span the road is designed for but the low grade (RR50 instead of the trunk road) is what is required for purpose.

Quality planning and life cycle costing

In chapter three we discussed about project and product life cycle. Formulating a project with a clear picture of the whole product life cycle will have a huge impact on the success and failure of the overall endeavor. For example, by looking the big picture, the designers of the project will be able to consider the trade-off cost of construction with that of cost of maintenance, upgrading (expansion) and disposal of the facility. Such approach of looking into the overall cost and return of the facility is known as *life cycle costing*. Thus, when project managers value engineer different alternatives in selecting the most appropriate way of delivering a project, it is of paramount importance that they analyze them based on the *product life cycle costs* rather than the simplistic *project life cycle cost*

The argument here is, in selecting between different technologies and construction methods, project managers are advised to check on the overall implications of the selected method/technology rather than choosing based on the limited benefit for the execution of the project. Thus, the technical specifications and standards chosen should enable the product serve its purpose to the best possible.

TQM principles and ISO 10006 quality management systems in projects

The TQM concept is a management philosophy developed by American scientists in Japan after the Second World War. It principally focuses in improving the 'total' aspect of a firm's business endeavor to improve quality. Following the success TQM has brought to firms, particularly in the manufacturing and service sectors, the ISO has adopted it as guideline (but not a certification criteria) for sustainable quality project delivery in its ISO 10006 quality management systems in projects.

The TQM basis on the following eight underpinning principles as means to achieve quality in processes, product, service, etc that a project may be expected to deliver/undergo.

1. *Customer focus*: The customer focus principle of the total quality is about striving to satisfy and exceed customers' needs and expectation. In this principle, the customer is the judge of the quality of the service or product. In 'customer driven' companies there will be a continuous interaction with customers, both internal and external. To create satisfied and loyal customers such companies assess the environment and explicate feedbacks from customers to explore the 'dissatisfiers', 'satisfiers' and 'exciters' of customers, both existing ones and potentials. Based on these factors the companies strive to exceed their customers' expectation by improving the quality of their internal operation and their relationships with their customers.
2. *Leadership style*: The ability of an authority to positively influence people and systems to work enthusiastically and effectively in order to accomplish objective has meaningful impact and achieve positive results. Leadership creates clear visible quality values, integrated into the organization strategy. To be able to successfully steer a project to completion, a project manager needs to be good enough in leading and motivating its project team and stakeholders. The leadership style which most companies who are excelling in TQ principles are employing is that of 'theory Y' assumptions which is founded on the theory that:
 - i. *The expenditure of physical and mental effort in work is as natural as play or rest.* The average human being does not inherently dislike work. Depending upon controllable conditions, work may be a source of satisfaction (and will be voluntarily performed) or a source of punishment (and will be avoided if possible).
 - ii. *External control and the threat of punishment are not the only means for bringing about effort toward organizational objectives. Man will exercise self-direction and self-control in the service of objectives to which he is committed.*
 - iii. *Commitment to objectives is a function of the rewards associated with their achievement.* The most significant of such rewards, e.g. the satisfaction of ego and self-actualization needs, can be direct products of effort directed toward organizational objectives. Leaders need to be and acknowledge works of their team member and reward it accordingly.
 - iv. *The average human being learns, under proper conditions, not only to accept but to seek responsibility.* Avoidance of responsibility, lack of ambition, and emphasis on security are generally consequences of experience, not inherent human characteristics.
 - v. *The capacity to exercise a relatively high degree of imagination, ingenuity, and creativity in the solution of organizational problems is widely, not narrowly, distributed in the population*

Under this theory then, the project leader's main task is to coordinate activities and facilitate for the work, motivate the actual people who are doing the work by providing the appropriate recourse and rewards, etc. Thus to usefully lead a project to its completion, the project manager need to be visionary enough to speculate about the future and 'see' in different direction, passionate and inspiring enough to motivate his team and explicate their commitment for the job and courageous and innovative enough to make decisions and see ways of getting out of trouble.

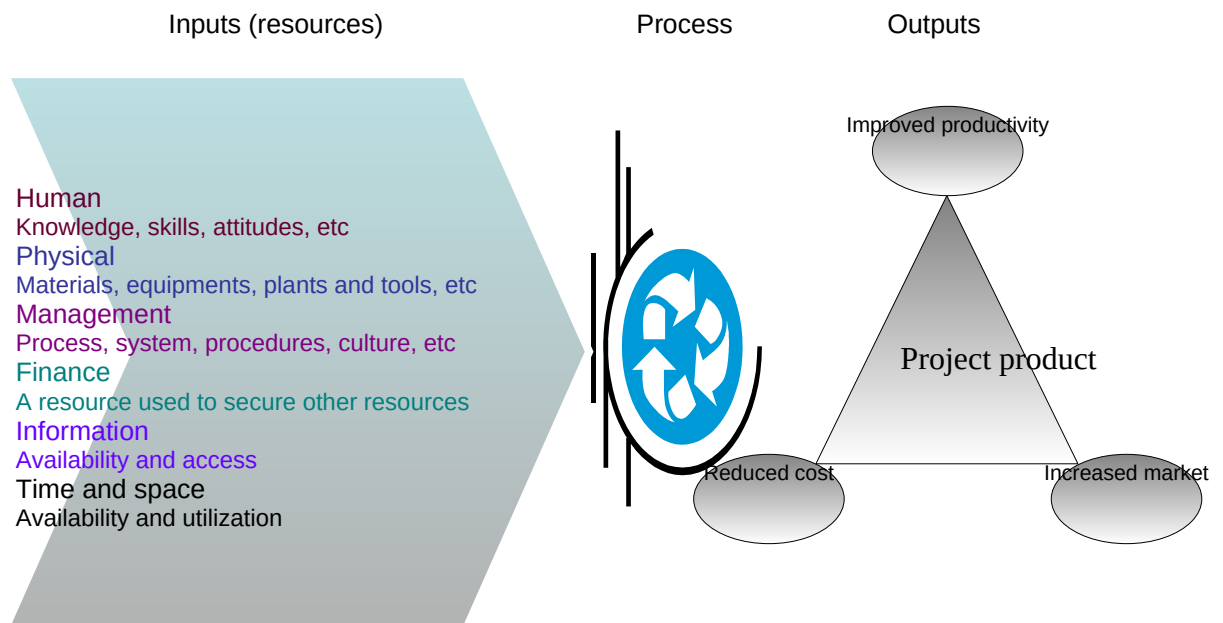
3. *Involvement of people.* Employee involvement and empowerment refers to any activity by which employees participate in work related decisions and improvement activities and are encouraged improving them selves through practice, training and education. Empowerment and involving people who are actually doing the work in decision making will develop trust in team members, encouraging co-operation and improves commitment of members to the success of the project. By empowering employees and encouraging teamwork and training, the project management team then enhances the success of the project.
4. *Process approach:* The process approach concept of the TQ principle is about focusing on the processes needed to do the job and improving the affectivity of those processes along with leveraging the interfaces b/n departments. It includes translating customer requirements into product and service design requirements, ensuring quality is build into product, effective management of the product development process, managing supplier and partnering relationships, controlling quality and operational performances, improvement in benchmarking, reengineering to encourage continuous improvement, etc. One of the main leverage areas of this approach lies in cross-function (inter-departmental) management. On the cross-functional level, the process approach is mainly about bridging the gap created by Fayol's management philosophy of departmentalization. One of the famous concept which come into the fore as a result of the process approach of a job is the concept of '*Concurrent Engineering*' where by people from the different departments will be asked to contribute to the design phase of the work. This is in contrast to the traditional management method of leaving, for example, the design to the design department.
5. *Systems approach to management;* the system theory is based on the dogma that 'the whole is more than the sum of the parts' (Flood, 1999). In management process which adopts this theory, the main focus is to coordinate the processes and departments involved in the actualization of the process so that the overall project is a success rather than optimizing on silos, say of having a world class design but difficult or virtually impossible to implement it. On another view of the system's theory, the project is leveled a success by optimizing life *cycle costs* rather than only concentrating on the cost of implementing the project. In a project environment, the application of the system thinking is thus more of holistic approach of measuring success.
6. *Continual improvement:* The concept of continuous improvement is tricky in its application in a 'single' project like construction works. A project, by definition, is 'a temporary endeavor undertaken to create a unique product or service' (PMBOK 2000a). So if one is creating a 'new' output, improving on it might be difficult as one is doing on it for the first time anyway. This doesn't mean however that there can't be any historic data to learn from and pass from projects to projects. The Egan report (1998) on construction for example claims that construction projects are about 80% repetitions, with quantity surveying data coming from previous lessons, design procedures improved from previous codes and practices, construction techniques and approaches used again and again. Moreover, even with in the project life span, the project management team can learn a lot to make it continually improve as the project moves forward. Indeed, that is the hallmark of project monitoring and evaluating-to improve on previous performances based on the knowledge gained.
7. *Factual approach to decision making (Management by facts).* This principle of TQ is the backbone of the ambition of a company's continuous improvement programme. If decisions are made in an ad hoc manner with out knowing why such decisions are made, their won't be many good lessens learnt from the out come of that decision, even if that decision turns out to be positive in that particular occasion. Thus an organization needs performance measures to drive strategic organizational change, manage resources for the direction, evaluate and operate processes for continuous improvement, etc. Factual approach to decision making, alternatively

known as 'statistical thinking' will also enable companies 'to manage their management approach' by enabling them make informed decisions.

8. *Mutual beneficial supplier relation ships*; This concept of working together b/n parties for mutual advantage, called partnering when the parties enjoy working together for a long time it another key concept in improving performance and adding value to the customer. Long term working together enhances the understanding of the needs and working process of the other part in the supply chain. This will help the parties to work on the processes which can help improve their relation ships and work together in adding value for the final customer of the product/service and hence their by improve their long term business guarantee. The construction industry is known for adversarial supply chain relationship where by the trend is always going for a bid and picking up the lowest bidder. Egan (1998) claims that this trend coupled with the fragmentation of the industry as compared to other industries has made construction projects full of disputes and litigations. Thus, adopting a mutually beneficiary supply chain is of big advantage to the industry in general.

Resources are the corner stone of project endeavors. In any endeavor, resources are the basic inputs to achieve a certain output. In a given firm, the following are the major categories of resources that the firm normally taps into:

- ❖ Institutional resources (reputation, organization culture, organization capability, management style & experience, etc)
 - Need to be cultivated, nurtured and exploited to gain a competitive edge
- ❖ Finance (Money): the most liquid resource of a firm
 - The major resource used to *secure* other resources
- ❖ Human (capacity (how many?) and capability (how capable?)):
 - Is the resources that actually *does* the job
- ❖ Physical (Material, Equipment & Plant):
 - The major resources *used* to do the job
- ❖ Information (Availability & access)
 - As the saying goes “information is power!”
- ❖ Time and space
 - Every endeavor is time and space limited.



Thus, the onus lies on the project management team to properly coordinate these resources and take the best out of them.

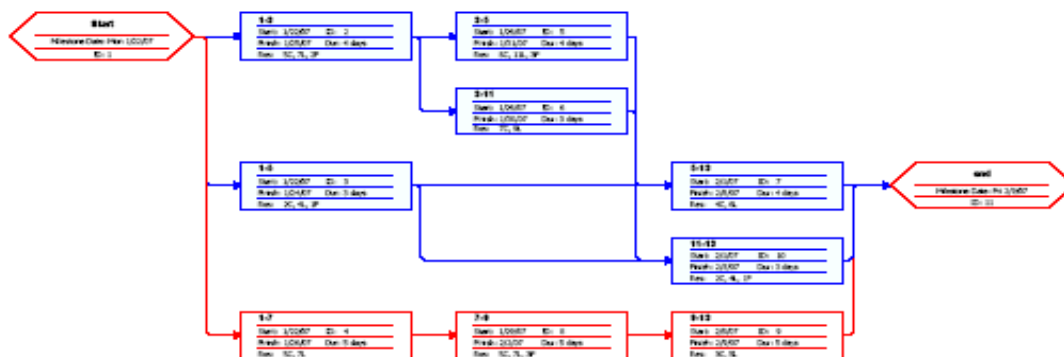
In construction works, the conventional and easy to notice resources are the human resource, the material and the machine resource. A material resource is a resource which is consumed while executing the project work, while a machine resource (includes equipments, plants, tools etc) is a resource not directly consumed in erecting the infrastructure but used to erect it.

The appropriate management and utilization of the three major resources: material, equipment and human resource is very crucial for the success of construction project. These resources take, with different proportions based on their involvement, the bulk amount of the project cost. In this regard, depending on the level of mechanization, construction projects are classified as *labor intensive* projects and *machine (equipment) intensive* projects. Such works as building constructions (low rise), small scale irrigation projects, rural community road projects, etc are labor intensive ones while such projects as road constructions, hydropower projects, etc are hugely machine driven.

Assignment: Discuss the relative advantages and disadvantages of labor-intensive and machine intensive construction works!

The management of resources involves:

- Resource estimation and selection: The type of resource to be deployed and its amount are inherently linked to the scope of the work to be executed and duration of time the works needs to be executed. Moreover, for work resources the amount resources needed depends on the productivity of the resources earmarked to be deployed and their *optimum combination*. Productivities and optimum combinations can be determined by manufacturers manual (for equipment's), productivity guidelines (usually supplied by standard agencies), past experience in similar conditions or self testing for optimum combination and productivity.
- Resource scheduling & checking resource availability: a clear time table needs to be set up to determine when certain resource is needed on site and for how long. These, indeed is highly dependent of the work schedule and time constraint of both the activities and the resources. Accordingly, a resource earmarked to execute a certain task at a certain time should be made sure that it is available at that specific time. Clearly, project scheduling should take into consideration these facts. Generally, checking resource availability should consider both company resources and possibilities outside the company (renting/leasing of equipments, etc), commitment of resources on other projects (the general construction market, the resources tied up on projects the company is performing, etc), possible leaves (sick, holidays, annual leaves, etc for human resource; maintenance, overhauling, etc for equipments, seasonal un available times for materials; eg summer, etc). The outputs of the resource scheduling can be presented in resource loaded diagrams as the ones shown below.



The obvious advantage of resource-loaded diagrams is associated economics involved with resource smoothening. By applying the appropriate leveling technique, which is hugely simplified by employing resource loaded diagram, the project manager can save profits in his [her] project. However, resource loaded diagrams can also help:

- ✓ Identify in time resources that need lead time and act accordingly;
 - ✓ Cross check the trustworthiness/reliability of assumptions/estimation about execution of activities;
 - ✓ Avoid disputes b/n contracting parties about resources that needs to be on site during execution;
 - ✓ Facilitate cash flow preparation and budgeting.
- Resource deployment: In Ethiopian construction project works, most equipment resources, if they have to be bought, needs a significant *lead time* for their deployment from overseas. Thus, project managers have to allocate enough lead time and manage the deployment processes accordingly. Related to this, and mostly working for material resources, the project managers may also have to decide between *just in case stocking* and *just in time delivery*. Various factors, beside the time the resource have to work on a task, need to be assessed in deciding when to deliver the resource on site.

- Resource utilization: Appropriate utilization of resources is the corner stone of proper resource management. Once delivered on site, *a work resource's* downtime should be kept at minimum while wastage from material resources should be kept as small as possible. Right combination of *dependent resources*, appropriate maintenance schemes, proper motivational and leadership styles, appropriate inventory mechanisms, etc need to be practiced to make the best out of resources.

Recommendations in getting the best out of the resource at hand:

- ✓ Forecast resource requirements as early as possible and act accordingly;
- ✓ Assign resources to the activities where they can be most efficient;
- ✓ As practically as possible, use the optimum combination of resources;
- ✓ Exploit company resources with effective handling of them among various projects;
- ✓ When activities finish, move resource to other activities [especially critical ones] immediately;
- ✓ Pre-manufacture components before they are needed and tie resources in such activities during slack time. However, check the trade-off between resource utilization and the additional cost of assembly and handling;
- ✓ Maintain equipments during slack time;
- ✓ Train workforce during slack period on skills that could add productivity and motivation.

Hire out resources if not needed in the foreseeable future

- Resource demobilization: after serving their purpose on the project site, resources should be demobilized as expediently as possible to another site.

PROJECT COMMUNICATION MANAGEMENT

Communication entails the formal or informal way of interacting with people. In a project environment, it incorporates timely and appropriate generation, collection, distribution storage, retrieval and ultimate disposition of project information to the appropriate recipients. Indeed it is through proper communication that project managers/team leaders give:

- Direction to project teams
- Hold meetings with and pass decisions with various stakeholders
- Report performance and possible courses of actions
- Relay information and ideas to project participants, public etc.
- Etc

Indeed, researches indicate that major problems in both project and business works can be tracked back to failure in communications.

Communication includes:

❖ Interpersonal communications:

- Verbal communications where the message is transferred through formal or informal (face to face or in a virtual mode) verbal encoding. Such communication has the advantage of timely exchange of information, rapid feedback, etc while it also incurs such disadvantage as it needs backing in writing in case of contractual matters and could be difficult to communicate with ppl of various background,
- Non-verbal communications: Refers to gestures, vocal tones, facial expressions, body languages, dressings, etc. It is a powerful means of communications. Generally in an interpersonal communications:

Total message impact = Words (7%) + Vocal tones (38%) + facial expressions (55%)

For effective communication, there are various sets of skills that are needed such as

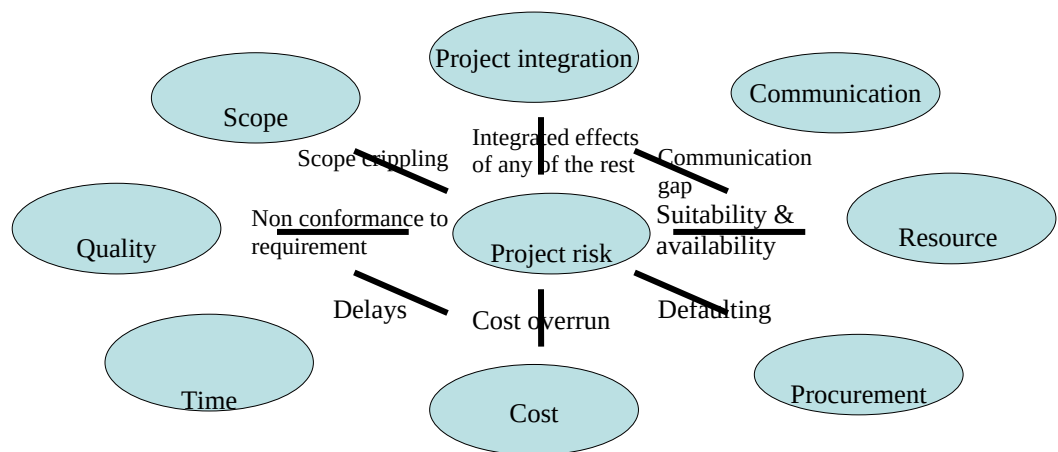
- ❖ Written communications is by far the dominant form of formal business communications that incorporates such issues like reports, plans, proposals, policies, procedures, legal documents, and other forms of documents presented in the form of letters, memos, emails, etc.

PROJECT RISK MANAGEMENT

Risk management is process of selecting ways of identifying, analyzing and responding to risks. It is concerned with risk management plan, risk monitoring and controlling, and responding to risks when they occur. It decides how to approach, plan and execute risk management activities for the various risks involved in delivery of a certain project.

Major risks in construction projects

Construction projects entail various risks. Particularly related to the nature of the production processes, products themselves, time it takes to produce, etc, construction projects are said to be risky businesses. Generally the nature of construction works entail susceptibility to *changing situations* such as weather conditions change, subsurface conditions change, etc while the long duration of project works is susceptible to market [price] changes, as well as change in demand of the facility delivered. Similarly, the huge works involved in construction and their 'non standard' nature incurs default performance by the parties involved in the delivery processes. In business, the higher the risk of doing a certain business, the higher the profit should be to embark in such business. Indeed, though the global profit margin in the sector is dwindling, construction projects works used to demand higher profit margins comparable to the risks involved. The figure below indicates the major risks associated in the sector.



Major Project Risks

Risk management principles and procedures

Generally, risk management involves identifying objectives, identifying risks, quantifying risk, responding to risks and controlling risks.



Procedures in managing risk

Objective identifications: Risk is highly associated with the objective of the project. For example, if the objective of the project demands doing works that are well standardized and can be finished within a

short period of time, the risk incurred is less. Put simply, the objective of the project dictates the potential risk that the project may incur. Therefore, the first step in risk management is to clearly identify the objective of the project. Unfortunately, even here, there is a potential risk of not properly defining objective.

Risk identifications: In risk management there is a saying that ‘once a risk is identified, it ceases to be a risk, it will become a management problem’. The saying is to emphasize that the most importance and difficult step in risk management is to identify potential risks. Once they are identified, the project management team would have a good chance of devising a possible way of dealing with them. Unfortunately though, it is quite difficult and there aren’t universal guidelines in identifying risks. Previous experiences, document reviews, process flow charts, cause and effect diagrams, Strength Weakness Opportunity and Threat (Challenge) (SWOT(C)) analysis, etc are available techniques.

Risk quantification: risk has two dimensions: *probability of occurrence and impact if it occurs*. Responses to risk generally depend on these dimensions. Therefore, these items need to be quantified before deciding on how to respond to a risk. *Sensitivity analysis, decision tree analysis, expected monetary value analysis and most of all Monte Carlo simulation techniques* are some of the available techniques hat are in common use.

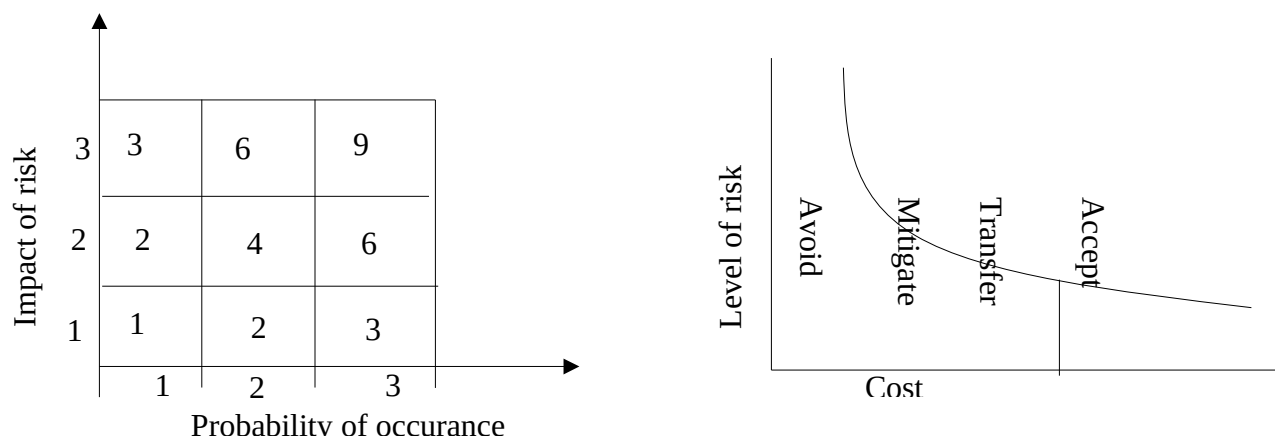
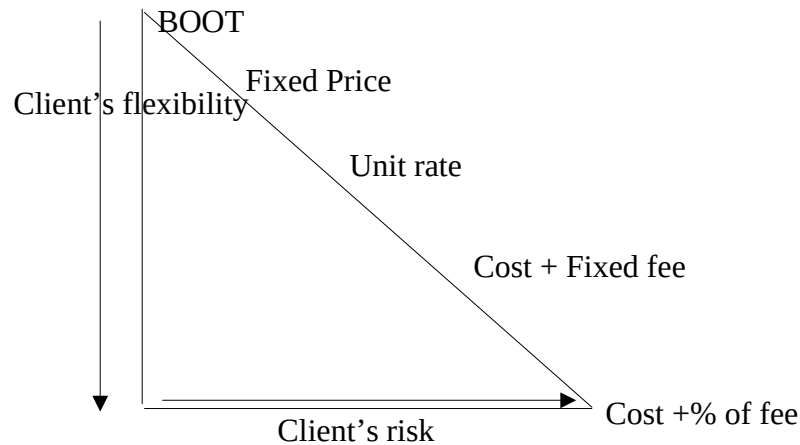


Figure 3: 6 Risk analysis and risk response scheme

Risk response: Once risks are identified and quantified, ways of responding them should be devised should they happen. Generally, the available mechanisms are:

- **Avoiding risk:** tries to avoid the risk by either removing the cause of the risk or completely abandoning the risky endeavor. This option is usually implemented early in the project life cycle where there is high level of influence on courses of action. Normally, high probability of occurrence and high impact risks are better left out.
- **Mitigating risk** is a process of looking for ways of reducing the probability and/or impact of the risk. Some risks can be reduced before embarking on the business. In construction, one of the basic arguments for using the DBB form of delivery is that it reduces risks (as design documents will be ready before embarking construction). Similarly such activities as design checkups, professional requirements on project works, etc are ways of reducing risks.
- **Deflecting (transferring) risk** and an approach of deflecting the risk (partially or wholly) to another party. Contracting is the common form of risk transfer in the construction industry. In contracting, the client is transferring the risks associated with the work had it executed them by itself while the contractor while demand a reimbursement equivalent to the perceived level of risk associated with the risk. Different delivery mechanisms and contracting types are said to have different level of risk on the client.



- Accepting risk: here one accepts the risk (self-insurance) because it may be not economical to respond to risk in other ways. Such is the case when the risk is believed to have low impact and/or low probability of occurrence. However, even in accepting risks, it may be necessary to devise a *contingency plan* to cater for the risks if they materialize.

Risk control: This involves the processes that monitor risks and implements courses of dealing with them. The processes implement the risk management plan and it ensures that risks are continually followed; assessed, analyzed and appropriate courses of actions are implemented. Generally, the risk management plans are updated and communicated to interested parties in a given time interval-say weekly, monthly etc depending on the nature and complexity of the processes.

PROJECT PROCUREMENT MANAGEMENT

Procurement is the process that creates, manages and fulfils contracts. Procurement as such forms an integral part of construction projects and occurs at any point in a project cycle where external resources are required to provide supplies and services in any combination or in the disposal of surplus plant, equipment and materials and the demolition of redundant buildings and infrastructure. Generally, the demand to procure occurs either a company is incapable of executing the procured item (resource tied up, etc) or other can execute the job better (with more efficiency) than the procuring company.

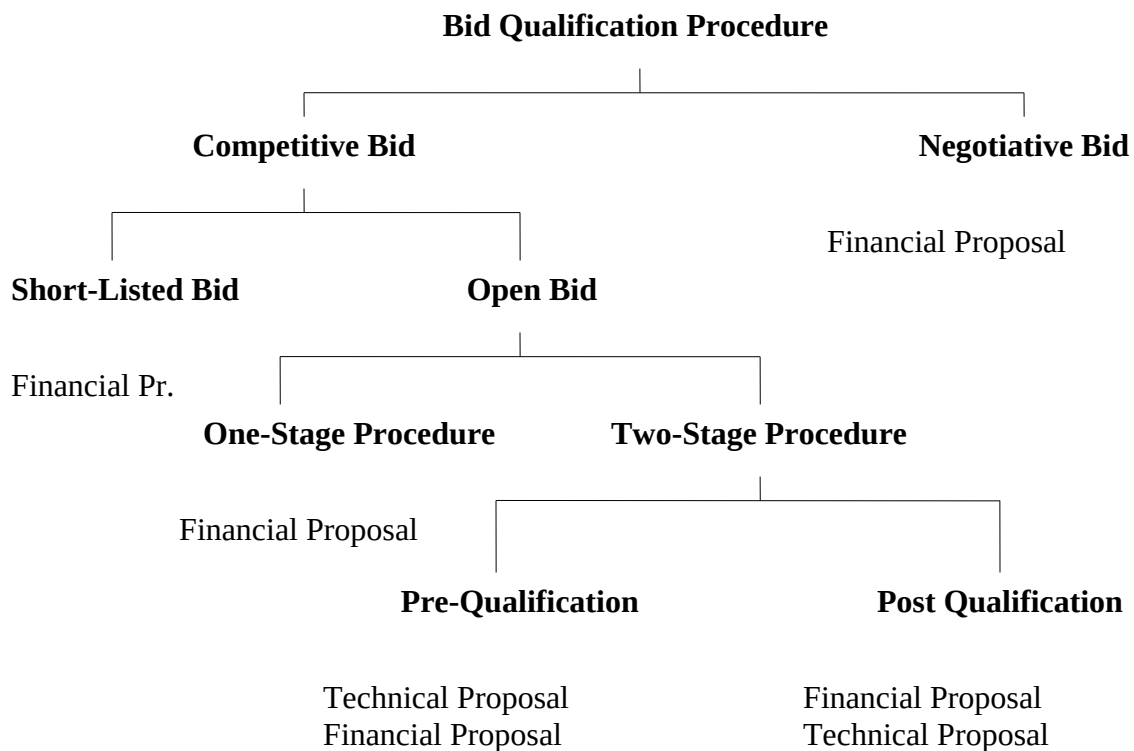
Processes in procurement involve those processes needed to determine what is to be procured via through to those processes contract administration and closure.

Activity		Steps	
#	Description	Inputs	Procedural milestone (control point)
1	Establish what is to be procured	Prepare broad scope of work for procurement	
		Estimate financial value of proposed procurement	
			Obtain permission to start with the procurement process
2	Decide on procurement strategies	Establish contract and pricing strategy	
		Establish targeting strategy	
		Establish procurement procedure	
			Obtain approval for procurement strategies that are to be adopted
3	Solicit tender offers*	Prepare procurement documents	
			Obtain approval for procurement documents
			Confirm that budgets are in place
		Invite contractors to submit tender offers or expressions of interest	
		Receive tender offers or expressions of interest	
		Evaluate expressions of interests	
		Prepare evaluation report on shortlisting process	
			Confirm shortlist
		Invite tender offers from shortlist	
4	Evaluate tender offers*	Open and record tender offers received	
		Determine whether or not tenders offers are complete	
		Determine whether or not tender offers are responsive	
		Evaluate tender submissions	
		Perform a risk analysis	
		Prepare a tender evaluation report	

			Confirm recommendation contained in the tender evaluation report
5	Award Contract	Notify successful tenderer and unsuccessful tenderers of outcome	
		Compile contract document	
			Formally accept tender offer
		Capture contract award data	
6	Administer contracts and confirm compliance with requirements	Administer contract in accordance with the terms and provisions of the contract	
		Ensure compliance with requirements	
			Capture contract completion / termination data

Major forms of bidding

Before a contractor is awarded a contract, it should likely be put through a qualification and selection process on order to arrive at the best advantage to the client in both price and efficiency. The following chart depicts the available options in bid qualification procedure.



Negotiated Bid: this is a bid arrangement where a client invites, negotiates and enters a contract agreement with only a single contractor. Generally, especially in public projects, such type of bidding is not recommended. However, it is allowed under specially conditions such as:

- In need of specialized service of a contractor,
- In the case of continuation of a contract which was already won by competitive bidding,
- For compatibility purposes with existing facilities,

- In the case of emergencies, etc.

Competitive Bid: In a competitive bid arrangement equi-potential and competent contractors are invited to provide their best offer to the bid. Contract is awarded to the most responsive bidder based on a bid evaluation process to be carried out consequently.

Short-listed Bid: A bid arrangement where the client directly selects two or more contractors who are technically fit to the project based on their past performance record. The bid evaluation process takes place among these contractors considering only their financial offer. Often the one that offer the least will be awarded the contract.

Open Bid: Any contractor qualifying the minimum requirement in the invitation to bid and wishing to participate is allowed to compete in the tender. There are two forms of open bid. Namely: the single-staged procedure and two-staged procedure. In the single-staged bid, contractors will be required to submit only a single document upon which bid evaluation would be conducted and the least and most responsive bidder will be selected for contract award. A two staged procedure requires submittal of two separate documents that comprise technical and financial proposal. The evaluation process to take place in the two-staged process will be either the pre-qualification or post-qualification.

Prequalification process: Assessment and evaluation of the technical proposal of contractors is made prior to opening the financial offers. Financial proposal will be opened if only the contractor attains the minimum passing mark fixed by the evaluators. Financial evaluation will take place among contractors who are found technically qualified to undertake the project. Technical proposal usually encompasses Contractor's:

- Eligibility and registration by authorized body,
- Past and relevant experience to the work,
- Capability to the work in terms of key staff, equipment, and methodology proposed,
- Financial position,
- Safety and health management improvised so far.

Post qualification process: Technical evaluation of contractors will be performed after opening of the financial offer. The technical proposal of the least bidder is first evaluated and if it is found satisfactory, the contract will be awarded without assessing the technical proposal of others. If, however, the least bidder is not found responsive to the bid, then the second least bidder will be evaluated for its technical fitness to the work. The procedure continues until the evaluators determine a contractor that would best fit to the requirements of the bid.

Major components of the procurement document

Procurement documents comprise several component documents dealing with different topics bound together in a logical sequence.

Generally a procurement document should comprise those documents required to:

- a. Pre-qualify tenderers so that they may be invited to tender;
- b. Solicit tender offers; and
- c. Establish the terms and conditions of the contract.

In doing so, procurement documents should in general:

- i. Require tenderers to submit particulars sufficient for the employer to evaluate submissions and to shortlist tenders, or to award a contract in a fair, equitable, transparent and competitive manner;
- ii. Set out in a clear and unambiguous manner criteria by which submissions are to be evaluated;
- iii. Define the liabilities, rights and obligations of the parties to the contract;

- iv. Define the nature, quality and quantity of supplies, services or works to be provided in the performance of the contract;
- v. Contain provisions that do not unreasonably prejudice the interests of either party; and
- vi. Use clear and unambiguous language.

Thus, in a cluster of documents, procurement documents can be classified as those documents that are relevant to *tender enquiry* and those documents that relate to *contract* upon the acceptance of the tender.

Contents		Function and broad outline of contents
Number	Heading	
Tendering procedures		
	Invitation to Tender	Alerts tenderers to the nature of the supplies, services and engineering and construction works required by the employer and should contain sufficient information to enable them to respond appropriately. It often includes The name and address of the Client, a brief description of the project (type, size and location) including desired time for completion, the means and conditions for obtaining the bid documents and the place from which they may be obtained, the place and deadline for the submission of bids, the place and time for opening of bids.
	Instruction to Tender	This is a separate document in the tender to furnish instruction to bidders on the preparation and submission of the bids. Although it may repeat some of the information in the invitation to bid, the instructions are mostly concerned with instructions about filling out the bid form, bid due date, location to deliver the bid, examination and evaluation of bids method of awarding the contract, bid security information, conditions to become non-responsive to the bid.
Returnable documents		
	Tender Form	The tender form is the document upon which the bidder submits its offer such as financial, technical and legal requirements of the bid. The form is usually prepared by the designers with blanks left to be filled out by the bidder. This makes the bids more easily comparable. Item usually includes some or all of the following: Name of contractor, unit prices for the bill of quantities, basic price index, tender sum both in numbers and in words, technical information such as key staff to be deployed, equipments to be availed, past experiences, etc, legal status of the company, proprietorship, corporation, partnership, financial status of the company, key subcontractors, time required for the job by the contractor, signature, title and date.
	List of Returnable Documents	Ensures that everything the employer requires a tenderer to submit with his tender is included in, or returned with, his tender submission.
	Addenda	These are changes issued after the documents are issued but before the bids are due.

Contents		Function and broad outline of contents
Number	Heading	
Agreements and contract data		
	Form of Offer and Acceptance	This form formalizes the legal process of offer and acceptance. The following provisions are common to most agreement forms: Identification and full address of the signing parties, short description of the project and the work, date of commencement and signature, completion time of the project, the contract price, and enumeration of contract documents constituting the entire agreement.
	Standard or General Conditions of Contract:	States the applicable conditions of contract and associated contract specific data that collectively describe the risks, liabilities and obligations of the contracting parties and the procedures for the administration of the contract.
	Particular or Special Conditions of Contract	This document provides more specific and relevant information and conditions to a particular project. It is a supplementary and modified section of the general conditions of contract. Special conditions include additional owner requirements.
Pricing data		
	Activity Schedule / Bill of Quantities	Records the contractor's prices for providing supplies / services / engineering and construction works which are described elsewhere in a specification within the Scope of Work section of the contract.
Scope of Work		
	Technical Specifications & Methods of Measurement	Specifies and describes the supplies, services, or engineering and construction works which are to be provided and any other requirements and constraints relating to the manner in which the contract work is to be performed.
	Drawing	These are intended to describe the size and dimensional requirements of the project. Many professionals are involved in developing drawings. These include the architectural, structural, sanitary, mechanical, electrical, topographic survey, land profile, and detailing.
Miscellaneous		
	Appendix to Construction Agreement:	Comprises tabulated and narrative information of the project such as amount and liquidated damages, interest rates, completion time, amounts of bond and insurances, defects liability period, retention, progress payments, advance payment, etc. Some of this information might be left blank to be filled by the contractor or might be readily provided by the client.

Common forms of contracts in construction

There are different variations of contracts in common use in the construction industry. Clients choose from among these forms based on their specific needs and objects. The risks associated and hence the potential rewards vary with the type of contract adopted.

A. Fixed price contract.

In this type of contract, the parties contracting agree on a pre-determined price to execute the contract. This pre-determined amount can only be altered by changes to the contract. There are two variations of these forms of contract:

i. Lump sum contract.

In this form of contract, the parties agree on the total amount of money required to complete the contract. Thus, as a general practice, the contractor doesn't have to show the specific breakdown of costs and match it to the specific work executed. However, to combat problems arising from a possible change in the contractual item, the contractor may be asked to specify the unit price of each of the major works to be done. In this way, when there is a change to the agreed items, the new cost of the changed item may be calculated by multiplying the amount to be executed by the unit price.

This form of contract's major advantage is that both the client and contractor know the extent of their commitment in advance. For example, the client knows his cost along with the cash flow, while the contractor knows the whole of his duties and can accordingly make tradeoffs between resources and projects. However, the approach has a major disadvantage of being not tenable for a project whose design is not finished. Unless the design is substantially finished, the contractor wouldn't know the whole extent of the work and couldn't come up with the total cost of the project.

ii. Unit price contract

In this form of agreement, the parties agree on the unit price of each and every item to be executed. Though the contractor is asked to come up with the total sum of the project work, in this form of arrangement, it is the unit price of the items specified that governs the project work, i.e., if there is some kind of discrepancy between the total sum and unit price multiplied by amount of work to be done, the latter takes precedence. Moreover, if there is a change in the amount of work to be done, the contractor would be asked to do it by the unit price rate submitted during the bid stage unless the change is considerable and warrants change in the unit price rate.

This form of arrangement generally has advantage over the lump sum contract. For example, as stated above, it is more adaptable to changes in the amount of work to be done. Besides, it can be used in cases where the detail design is not finished by asking the contractor to make a rough estimate of the work to be done and submit a unit price accordingly and hence promotes open competition involving quantities of work that cannot be accurately forecast at the time of bidding. Perhaps the major downside of this approach is that it takes a relatively long span of time and higher cost for the preparation of specification and detailed bill of quantities.

B. Cost-Plus Contracts

In cost-plus arrangement, the contractor will be paid for the costs incurred for the execution of the project plus an agreed amount of profit margin. Generally this type of contract is suitable for negotiated contract between the contractor and the client. The form of arrangement is usually used in innovative projects where it may not be possible to have a predefined unit price as the project is the first of its kind and won't be easy to determine the amount of man hour needed to execute it. Thus to use this arrangement, there can only be agreement on what constitute a cost, which generally can be categorized under materials, equipment, labor, contractor's staff (both project and overhead staff) and some other general conditions as in insurance etc. There are different varieties of this approach:

i. Cost plus percentage of cost

This type of contract fixes percentage of the cost of construction for the profits and risks to be due to the contractor. However, there is one big problem in this arrangement, contractors often try to exploit the arrangement via different means such as over staffing the project, not assigning the most competent resource, forging invoices etc. As a measure of partial counteracting of this problem, clients usually demand other variations of the cost plus contract.

- ii. Cost –Plus fixed fee

In the arrangement, the parties agree on the cost the contractor may incur to execute the job plus a fixed fee to cover for the contractor's staffing costs, overheads, profits etc. Still the problem with this kind of arrangement is that, there is no effective counterchecking mechanism if the contractor tries to cheat by producing forged invoices.

- iii. Cost-Plus fixed fee with guaranteed maximum price.

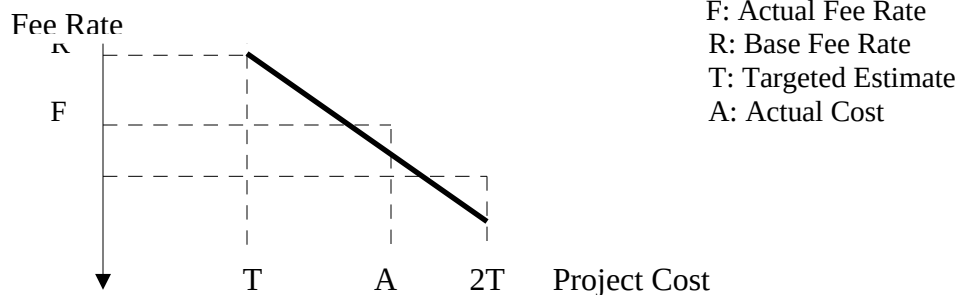
The arrangement is meant to prevent the project cost escalating above a certain maximum price. In the arrangement, the contractor will be reimbursed for the costs incurred, plus given an agreed amount of fixed fee to cover for its other expenses and profits. But in this arrangement, unlike the previous one, the agreement puts a cap to the maximum price the project can possibly escalate to. One of the major problems with this arrangement is the attitude seen by contractors to push the price always near to the GMP provided. To at least counteract this problem, clients usually provide a 'share in the saving' clause to the agreement. I.e, the contractor will be allowed to share (in the percentage agreed) the amount saved below the GMP. However, this arrangement still has a drawback as usually contractors try to push activities as 'change' so as not to be included in the agreed GMP. Hence to stipulate a 'share in the saving' clause, the contract has to clearly define what a change is.

- iv. Cost-Plus Sliding Scale Fee Contract:

A form of cost-plus contract that acts in the nature of a compromise between the percentage of cost fee and a fixed fee. It is one in which the fee is established in accordance with a sliding scale arrangement. Either of the following general schemes may be followed.

- a) The fee may be determined as a percentage of cost, with the percentage increasing as the cost falls below the target estimated and the percentage decreasing as the cost rises above the target figure.

$F = R (2T - A)$ Where,



- b) The setting of a lump sum fee for costs below the target estimate and decreasing it for costs above the estimate. Under either arrangement, a minimum fee or percentage is stipulated that is subject to no further decrease regardless of the final cost of the work.

$L.S = B.L.S (2T - A)$ Where,

L.S: Lump Sum Fee

B.L.S: Base Lump Sum

T: Target Estimate

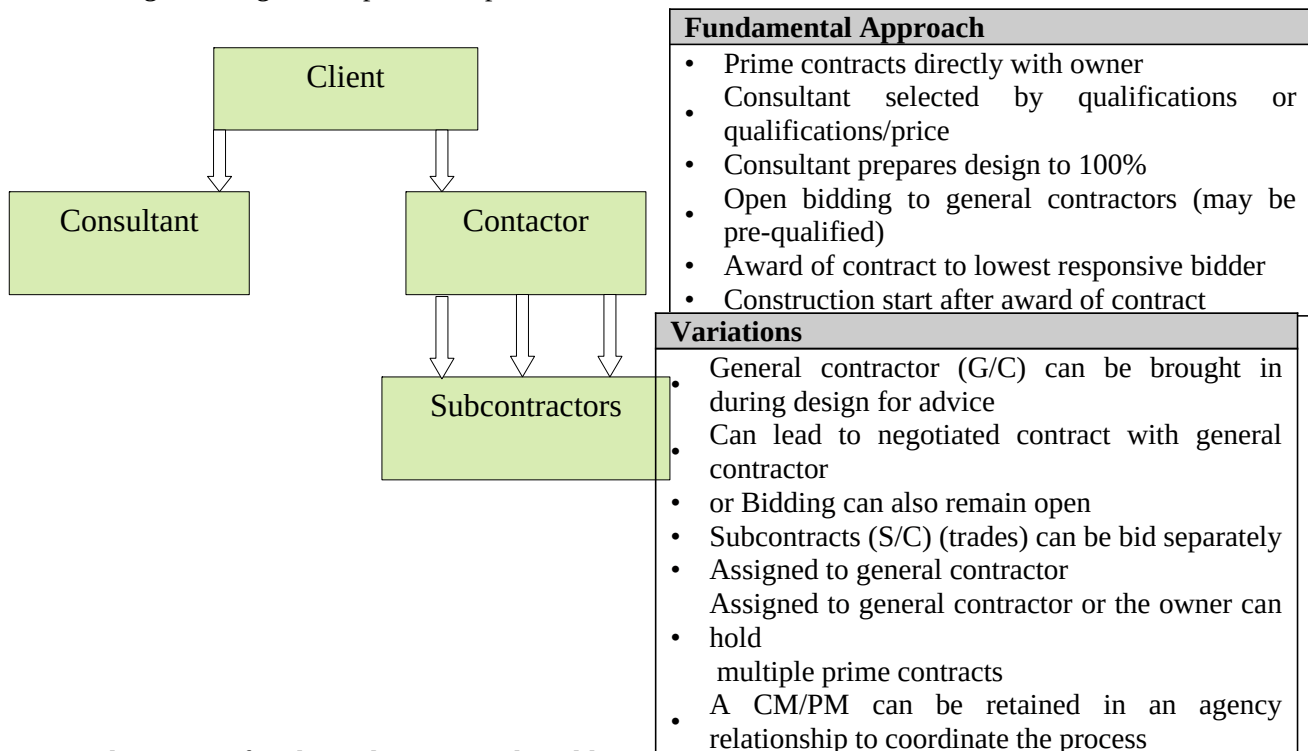
A: Actual Cost

Project Delivery Systems

The whole process of implementing projects, from need identification through to operation or facility management, traditionally has been a fragmented effort by the owner, the consultant and the contractor. It has been argued that this fragmented system has incurred serious inefficiencies in the industry and deprives the owner from getting the best value for his[her] money and effort. Along with these critics of the way the construction industry does business, there has been calls to improve the management of the planning, design, engineering and construction as the inefficiencies caused costly budget overruns, inadequate quality control, excessive delays and other project complexities such as customer dissatisfaction. As a result, starting the early 1970s, different management systems evolved to deal with these problems and issues. Although there are different variations, major forms of project delivery can be classified as design-bid-build, design-build, construction management and the different variations of the public private project delivery systems.

The traditional design-bid-build (DBB) approach

Construction practices traditionally have been based on an owner identifying a need and proceeding with the design-bid-build arrangements. The owner hires an architect/engineer to develop the design, plans and specifications in accordance with the owner's needs. The bidding process begins once the design is completed. Then after, the contractor who won the bidding implements the project according to the design specifications. The key feature of this approach is that each of these project participants is a separate entity and their roles are sequential in nature. This strategy of conventional processes of sequential project delivery system, which assumes that clients benefit from choosing a new set of project team selected competitively for every project they engage on, is meant to minimize risks and changes through thorough descriptions of specifications and contracts.



Advantages of traditional Design-Bid-Build

- The process embodies a design in a set of substantially complete documents that are capable of transmitting the owner's wishes to the constructor.
- The contractual relationships between the constructor and his/her subcontractors make it easy for the constructor to fire, replace, or take over from a subcontractor if he/she defaults

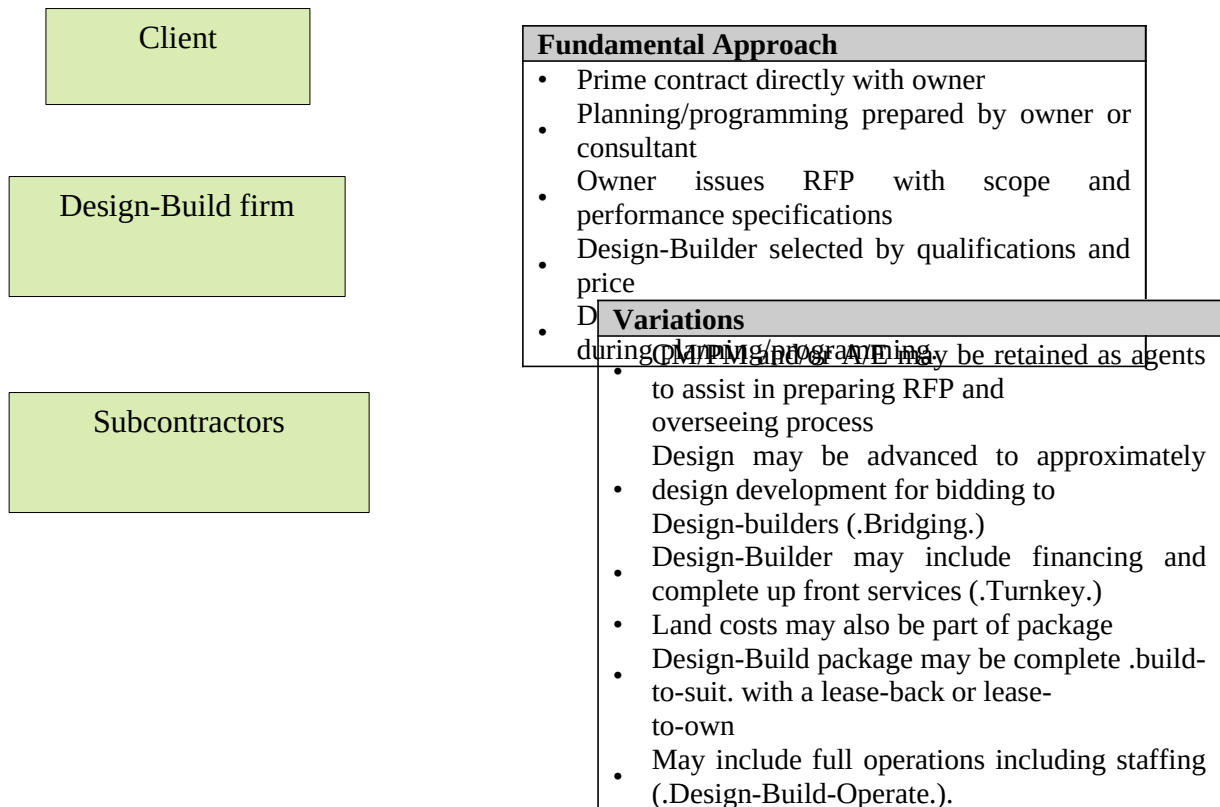
- Owners are often guaranteed the maximum price for completing the entire project.

Disadvantages of Traditional Design-Bid-Build

- Change order abuse often leads to unnecessary increase in the overall cost,
- The process is sequential in nature; the escalating factor between the time a project is conceived and when it is actually constructed can add significant cost. A delay in construction means that an owner is paying additional rent for his current facility or that production in a new manufacturing facility is delayed,
- Throughout the process, the owner has little or no direct control over what the facility will ultimately cost, but still pays the bill. During design or engineering, there is no sure procedure for evaluating the cost implications of the architect's or engineering's proposals. The proposed design or engineering may be impractical, or there may be simpler and cheaper techniques that provide the same result. Normally, alternative procedures become known only after the bid phase, when changes represent sweeping revisions and major expenditure of time and effort. Such changes would have been simple earlier. The owner is faced with the opposition of paying more than expected for the original design or engineering or waiting for a better process and receiving less for his money because of spiraling costs
- There are no real incentives for the general contractor to reduce the cost of the facility once it is under way; large incentives exist to increase costs. Subcontractors often quote a job low and then attempt to recover additional money during the construction in negotiations for changes and extras. Since the general contractor may work with these subcontractors in the future, she tends to side with them in claims
- Architect or engineers sometimes do not have enough familiarity with the construction process to control it as closely as the owner desires. Although the owner is called on to evaluate progress for payment, in practice he is seldom able to prevent the disproportionately high distribution of funds that tends to occur during the early stages of construction
- The traditional process doesn't create a unified system in which experience, feedback, and new ideas are shared
- On a project team in a design-bid-build, there is no overall management and coordination; there is an artificial separation of design, engineering, and construction; manufacturers are remote from the process
- In public procurement practices there is an excessive time span for the whole process, a limited basis for bid evaluation, no incentive to reduce long-term costs, and no guarantee of cost and time
- Within the owner's organization, there is inadequate economic analysis, a lack of long-term planning, and conflict over definitions of user requirements

Design-Build

The design-build method of project delivery is one way that reduces the number of contractual relationships that the client has to go into and the associated inefficiencies. In this method, the owner contracts with a single firm, which provides both the design and construction services. The process focuses on just two parties: the owner and the design-build firm. The argument is that, with few parties involved in the contractual relationship, the process becomes more efficient.



Advantages of Design-Build

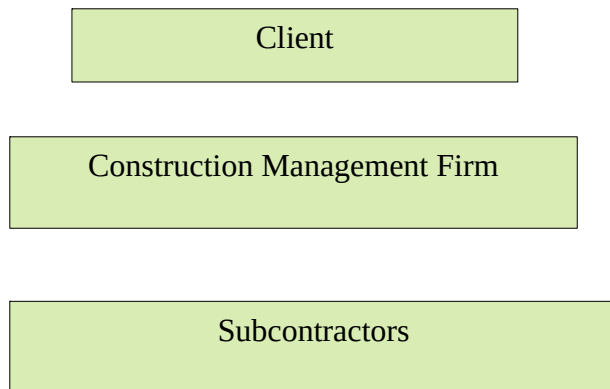
- A single contractual relationships is involved in design and construction; the concept allows for construction to begin even when the design is not complete. For owners, this means they can get a building in a much quicker time period. Problems are solved more quickly, since the designer and the contractor are both on the same team.
- Design-build provides better coordination, increased efficiency, lower costs, and usually improved quality.
- The process provides reduced administrative owner coordination between the architect/engineer, contractors and/or the CM
- It allows the use of phased construction to reduce design-build time.
- Design-build provides a tremendous opportunity for incorporating construction expertise during the planning and design phases.
- Changes are easier to implement.
- It takes the owner out of the center of debates when design and/or construction errors or omissions occur.
- Legally, the owner deals with one contractual entity instead of several unrelated parties.

Disadvantages of Design-Build

- The design-build approach does not provide owner representation on the design-construction team.
- It is difficult to determine and/or control the overall cost of the project, since design and construction are occurring at the same time.
- The owner doesn't have a firm project cost at the start.
- A design-build firm has control over the integration of design and construction functions.
- Quality could suffer in guaranteed maximum price or lump-sum contracts.

- Certain checks and balances between the designer, builder, and owner during the design and construction phase do not exist.
- The final result may differ from the owner's expectations because of the owner's minimal involvement.
- Any mistakes made by the designer can be covered up by the contractor if both are employed by the same company.
- The burden on the owner to select a qualified design-build firm is heavier than in other forms of project delivery.
- An additional design team often is required to develop scope drawings used for the design-build selection process.

3.1 Construction Management



Advantages of professional Construction Management

- The CM process allows a systematic approach to project management. By being involved from inception to completion, the CM firm can interrelate and control all relevant variables that influence the major success factors of time, cost, quality and customer satisfaction.
- The process enables a construction manager to contribute his/her knowledge early in the design phase. He performs value analysis and life-cycle cost analysis to ensure optimal design of project regarding the major measures of success.
- The construction manager, by his everyday involvement in the construction industry, has better access to contemporary information such as cost than most architects/engineers. [s]he is in a better position to make dependable preconstruction estimates. This improves project designs and prevents delays from duplications and project-letting iterations as a result of bid overruns.
- The CM firm offers an independent, objective manager working on the owner's behalf to provide integrated management for an entire project. The CM's management skills complement both the architect/engineer's design skills and the contractor's construction skills to procure optimal design and construction. The owner receives and information base for decision-making that is multi-disciplined and objective.
- The construction management process may minimize the owner's time commitment and need for in-house staff. When adequate trust exists, the CM should be able to make most decisions for the owner once the scope and budget are established. The CM can handle project planning, change orders, the selection of contractors, financing and monitoring the owner's cash. The CM can be structured to enable the owner as much involvement as he prefers.
- The CM's knowledge of the construction industry enables smarter purchasing of materials than other delivery systems. This prevents material shortage, lengthy project delays, or escalating material cost. The CM is expected to know and forecast the availability and cost of materials before the contract to install them is awarded. Long-lead items can be purchased early and expedited to arrive at the site when required.

- The CM approach enables project team members to concentrate on the functions and responsibilities that they perform best. The reduction of the architect/Engineers' involvement in estimating and contract administration offers a potential reduction of fees.
- The CM contract offers potential reduction in the contractor's overhead by the elimination of general contractor. This also increases fairness in competitive bidding by specialty contractors because they can bid directly as prime contractors, thus eliminating bid shopping, auctioning and other unethical practices.
- Competitive bidding by contractors in the CM contract gives the owner an opportunity to oversee bidding processes and selecting the best bidder.
- The direct relationship in the CM contracts enhances the contractor's early receipt of progress payment and owner-held retainer.
- The CM process may reduce or eliminate adversarial relationships. By emphasizing teamwork, the process encourages participants to work with, rather than against, each other, thus creating harmonious team.
- The use of separate owner-contractor contracts facilitates the phasing of design and construction. It is feasible to receive bids and performance from some early-phase contractors (excavation, foundation) before latter types of construction are designed. This overlapping of design, bidding and construction often results in considerable reduction in total project time, thus reducing the impact of inflation on project costs.

Disadvantages of the Professional Construction Management

- The CM approach is best suited for large projects because of the additional cost involved.
- The owner incurs additional cost over and above those paid to the architect/engineer and the contractor[s] when the CM is an addition to the traditional three party team. This may not be worthwhile investment if the potential benefits to the owner don't exceed the additional cost incurred.
- Many specialty contractors have weak finances, so it may be difficult to procure surety bonds. Some competent constructors may not be able to bid and less competition results in less competitive prices.
- When the construction manager doesn't have direct contractual relationship with the separate prime contractors, his perceived authority is reduced.
- It is difficult to organize, coordinate and control several prime contractors on the phase of fast-tracking contracts. Some problems associated with these contracts include difficulty of defining who is responsible for what in the overlapping trades. The specialty contractors assuming the responsibility that goes with prime contracting, and going through the tedious, expensive and time consuming processes on negotiating with bonding companies to obtain relief from a defaulted contractor.
- The CM who acts as the owner's agent has limited liability
- The leadership and management capabilities of CM personnel influence the relationship among the participants and also the effectiveness and efficiency of the CM process.
- It is dangerous to select a CM on the basis of price, because an unqualified and job-hungry firm can offer a price too good for an owner to pass up and then fail to perform efficiently.

Public-Private partnership

Infrastructure mega projects have often failed to meet original stakeholder expectations both in the 'pure' free market and totally central-planned economies. Experience shows us neither the public sector nor the free market provides infrastructure effectively

Following these widespread failures and the public sectors inability to finance all infrastructure project and its bureaucratic and inefficient management system, enveloped the concept of Public Private Partnership. It is believed that this form of public infrastructure delivery improves efficiency by

changing the traditionally adversarial procurement system to partnerships that integrate finance, design, construction and management.

The PPP is espoused to improve efficiency and synergy, increases revenues and reduces deficits/debits, quicker delivery etc. It is believed that PPP scenarios can overcome both market and government failures:

- The free market is often characterized by breakdowns, inefficiencies and inequalities;
- The public delivery is known for slow and inefficient decision making, derived externalities, unworkable bureaucracies, allocative inefficiency, dysfunction between output and payment.

Thus the impetus behind the PPP approach is that, the private sector, with its wide range of managerial, commercial, and technical skills, spurred on by the profit motive and unencumbered by layers of bureaucracy can reputedly perform certain tasks more efficient than the government, thereby offering huge benefit to the public. In parallel with this, it allows the public sector to concentrate on delivering services by freeing resources and time that could be tied up in delivering the infrastructure needed to deliver the services.

Many types of PPPs are in common use in the global infrastructure delivery system. Among these, buy-build-operate, built-lease-transfer, build own operate (BOO) build-own-operate-maintain (BOOM), build-own-operate-transfer (BOOT), design-build finance-operate (DBFO), and their variations. Wide ranges of infrastructure, like roads, bridges, ports, airports and railways in the transport sector, power, telecommunication, water supply and waste disposal in the utilities sector and schools, hotels, hospitals, military facilities and prisons have been delivered through the use of the PPP.

HEALTH AND SAFETY MANAGEMENT

Construction is the most dangerous and hazardous undertaking. In industrial countries, it accounts for about 10% of the disability injuries and 20% of the fatalities that occur in the industrial work force. Although we don't have the actual statistics in our country, there are significantly more injuries, death and lost workdays due to injuries or illnesses in construction than virtually in any other industry. These works related injuries and illnesses are exceedingly costly. It entails the following:

- Leads to disruption of the construction schedule and demanding significant time management even for investigation and reporting,
- Direct costs that include medical costs, premiums for workers' compensation benefits, liability and property losses etc. While contractors may pay insurance premiums directly to cover such costs, these costs are reflected in bid prices or contract amounts,
- Indirect costs that include:
 - reduced worker productivity,
 - Schedule delays in projects and administrative time,
 - Damage to equipment and the facility,
 - First aid expenses,
 - Idle equipment time,
 - Loss of skilled worker
 - Administrative and legal expenses
 - Lowered employee morale
- Injuries on bystanders (Third Party) from construction accidents. Several crane collapses from high rise buildings under construction have resulted in fatalities to passersby.

The causes of injuries in construction are numerous. The under listed causes are reported accidents in the US construction industry in 1997. A similar catalogue of causes would exist for other countries too. The largest single category for both injuries and fatalities are:

- Individual falls: a railing might not be secured, a worker might be inattentive, and the footing may be slippery etc.
- Handling of goods: falling from an elevation being struck by something,
- Transportation incidents,
- Being caught between two objects,
- Electric shock.

While eliminating accidents and work related illnesses is a worthwhile goal, it will never be attained. Construction has a number of characteristics making it inherently hazardous. Large forces are involved in many operations. The jobsite is continually changing as construction proceeds. Workers do not have fixed worksites and must move around a structure under construction. The tenure of a worker on a site is short, so the worker's familiarity and the employer-employee relationship are less settled than in manufacturing settings. Despite these peculiarities and as a result of exactly these special problems, improving worksite safety is a very important project management concern.

Various measures are available to improve jobsite safety in construction. This includes:

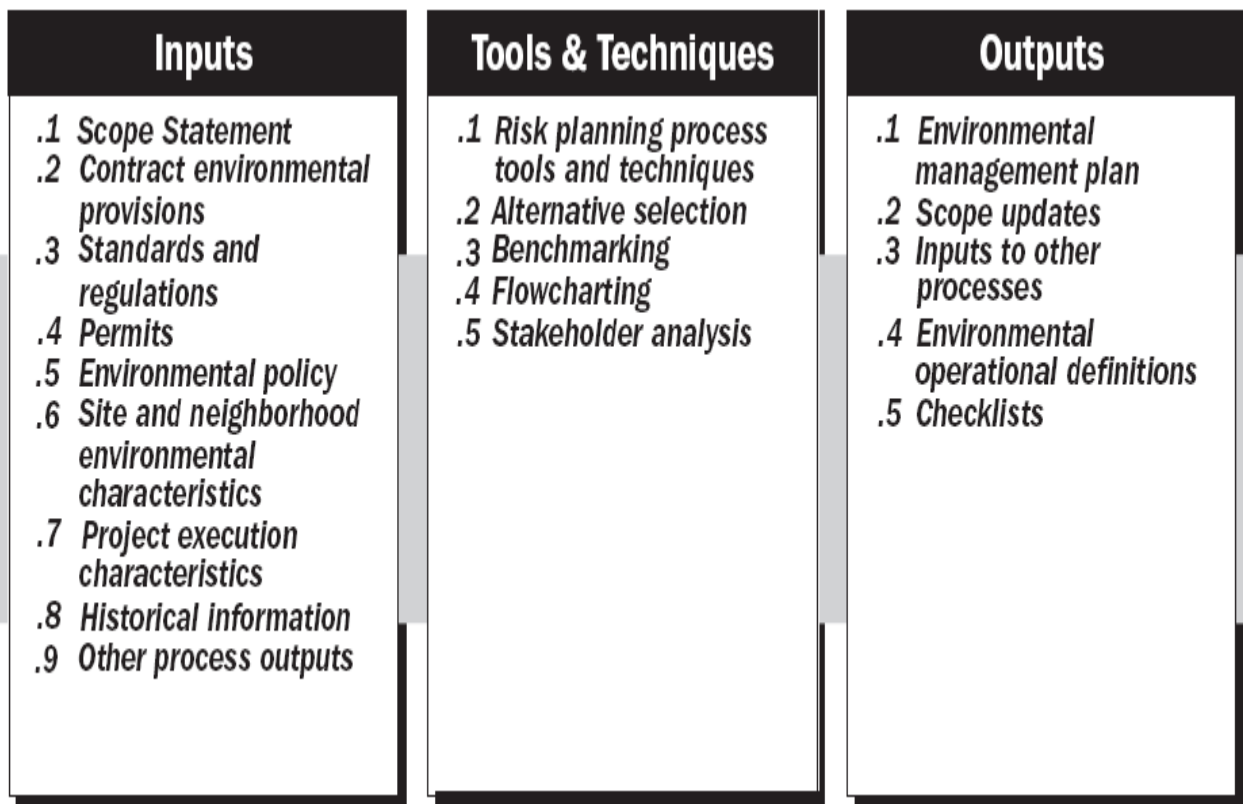
- Educating workers and managers in proper procedures and hazards can have a direct impact on jobsite safety. The realization of the large costs involved in construction injuries and illnesses provides a considerable motivation for awareness and education. Regular safety inspections and safety meetings have become standard practices on most job sites.

- Perform a job hazard analysis prior to operation. This encompasses:
 - detailed description of the construction operation,
 - A listing of the hazard associated with the operation,
 - A plan of eliminating, reducing or responding to the hazardous situations.
- Prevent substance abuse: Workers under the influence of drugs or alcohol on the job site pose serious safety and health risks, not only to themselves, but also to all those who work in the proximity of the users. It is advisable to establish specific policies prohibiting substance use on project sites and people from working on site who are under the influence.
- Personal protective equipment:
 - Head protection (hard hats),
 - Hand protection (gloves),
 - Foot protection (Safety shoes),
 - Eye protection (safety glasses and goggles),
 - Body protection (protective clothing, oily body-paint),
 - Hearing protection (earplugs and earmuffs),
 - Respiratory protection (respirators),
 - Providing first-aid supplies and trained personnel on site.
- Hazardous Materials Communications: It is required that all personnel working on a construction site be informed of all chemicals being used on the site and any harmful effect they may cause.
 - Warning labels on all containers indicating the specific hazard posed,
 - Posting of material safety data sheets
 - Specialized training regarding the safe handling, transporting, storage and use of the chemicals.
- Pre-qualification of contractors and sub-contractors with regard to safety is another important avenue for safety improvement. If contractors are only invited to bid or enter negotiations if they have an acceptable record of safety (as well as quality performance), then a direct incentive is provided to insure adequate safety on the part of contractors.

PROJECT ENVIRONMENTAL MANAGEMENT

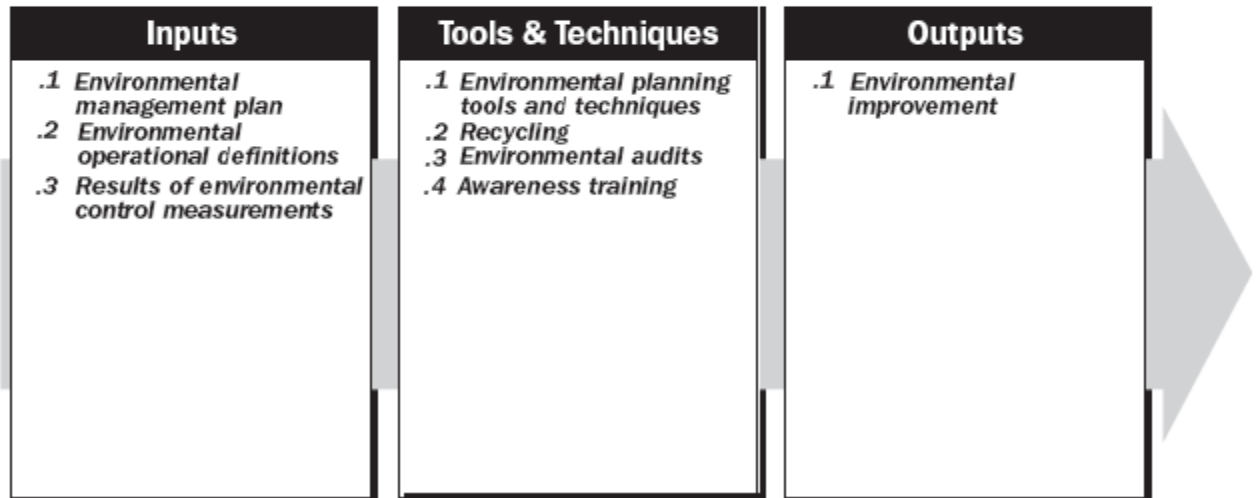
Project environmental management includes the processes required to ensure that the impact of the project execution to the surrounding environment will remain within the limits stated in legal permits. It is related with identifying the environmental characteristics surrounding the construction site and the potential impacts the construction may bring to the environment; planning the approach towards avoiding environmental impacts and achieving environmental conservation (and improvement if possible); auditing the plan and controlling the results; and inspecting environmental condition.

2 ENVIRONMENTAL PLANNING



ENVIRONMENTAL ASSURANCE

Environmental assurance is all the planned and systematic activities implemented within the environmental system to provide confidence that the project will satisfy the relevant environmental standards. It should be performed throughout the project. Assurance should be provided to all stakeholders, as environment conservation is a matter of global interest.



ENVIRONMENTAL CONTROLL

