ENG 502.2: Engineering Law (Professional Practice and Procedures)

Course Content
Introduction/ Review of Preliminary Concepts
Registration of Engineers, Duties, Code of Conduct and Practice. Ethics, Professional responsibilities and practice of Engineering in Nigeria
Engineering Projects, Planning and Feasibility studies and their relevance, guide-predesign survey and stages of Engineering design project scheduling. Typical Problems and solutions In Civil Engineering.
Law: Sources and branches of Nigerian Law, Court and tribunals. Law of contracts, the engineer as an expert witness. Typical Problems and solutions in Mechanical Engineering.
Industrial legislation concerned with; incapacity or injury, working conditions, wages, redundancy, trade unions, structure, right and liabilities. Industrial dispute, safety and environmental protection. Typical Problems and solutions in Marine Engineering.

Course Lecturers
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Lecture Topics:

Engineering Projects; Planning and Feasibility studies and their relevance; guide - predesign survey and stages of engineering design project scheduling.

Typical Problems and solutions In Civil Engineering.

Presented by:

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October, 2022

1.0 PROJECT PLANNING

Project Planning is an act of formulating a program for a definite course of action. It is also a process of drawing layouts for some project or enterprise.

The following are the importance of project plans;

- Project plans are used to coordinate rather than to control a project.
- It makes use of different personalities within the project environment.
- It prescheduled frequent revisions to project plans.
- It empowers workers to estimate their own work.
- It describes value-creating tasks rather than activities.
- It defines specific and tangible milestones.
- It uses check lists, matrices, and other supplements to project plans.

Planning is an ongoing process that is conducted throughout the project life cycle.

The basic components of a project plan are discussed below:-

- ***Outline of Project Plan -*** This is a brief description of what is planned.
- ***Approach -*** The managerial and technical methodologies of implementing the project should be specified***.***
- ***Objectives -*** The objectives should be very detailed in outlining what the project is expected to achieve.
- ***Policies and Procedures -*** Development of a project policy involving general guidelines for carrying out project.
- ***Contractual Requirements -*** The portion of the project plan should outline reporting requirements.
- ***Project Schedule*** - The project schedule signifies the commitment of resource against time in pursuit of project objectives.
- ***Resource Requirements -*** Project resources, budget, and costs are to be documented in this section of the project plan.
- ***Performance Measures -*** Measures of evaluating project progress should be developed.
- ***Contingency Plans -*** Courses of actions to be taken in the case of undesirable events should be predetermined.
- ***Tracking, Reporting, and Auditing -*** These involve keeping track of the project plans, evaluating tasks, and scrutinizing the records of the project.

PROJECT PLANNING PROCESS

The Project Planning Processes involves the following;

1. **Develop Project Management Plan:** It is the process of documenting the actions necessary to define, prepare, integrate, and coordinate all subsidiary plans. The project management plan becomes the primary source of information for how the project will be planned, executed, monitored and controlled, and closed.
2. **Collect Requirements:** It is the process of defining and documenting stakeholders' needs to meet the project objectives.
3. **Define Scope:** It is the process of developing a detailed description of the project and product.
4. **Create Work Breakdown Structure:** It is the process of subdividing project deliverables and project work into smaller, more manageable components.
5. **Define Activities:** It is the process of identifying the specific actions to be performed to produce the project deliverables.
6. **Sequence Activities:** It is the process of identifying and documenting relationships among the project activities.
7. **Estimate Activity Resources:** It is the process of estimating the type and quantities of material, people, equipment, or supplies required to perform each activity.
8. **Estimate Activity Durations:** Estimate Activity Durations is the process of approximating the number of work periods needed to complete individual activities with estimated resources.
9. **Develop Schedule:** Develop Schedule is the process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create the project schedule.
10. **Estimate Costs:** Estimate Costs is the process of developing an approximation of the monetary resources needed to complete project activities.
11. **Determine Budget:** Determine Budget is the process of aggregating the estimated costs of individual activities or work packages to establish an authorized cost baseline.
12. **Plan Quality:** Plan Quality is the process of identifying quality requirements and/or standards for the project and product, and documenting how the project will demonstrate compliance.
13. **Develop Human Resource Plan:** Develop Human Resource Plan is the process of identifying and documenting project roles, responsibilities, and required skills, reporting relationships, and creating a staffing management plan.
14. **Plan Communications:** Plan Communications is the process of determining project stakeholder information needs and defining a communication approach.
15. **Plan Risk Management:** Plan Risk Management is the process of defining how to conduct risk management activities for a project.
16. **Identify Risks:** Identify Risks is the process of determining which risks may affect the project and documenting their characteristics.
17. **Perform Qualitative Risk Analysis:** Perform Qualitative Risk Analysis is the process of prioritizing risks for further analysis or action by assessing and combining their probability of occurrence and impact.
18. **Perform Quantitative Risk Analysis:** Perform Quantitative Risk Analysis is the process of numerically analyzing the effect of identified risks on overall project objectives.
19. **Plan Risk Responses:** Plan Risk Responses is the process of developing options and actions to enhance opportunities and to reduce threats to project objectives.

20. Plan Procurements: Plan Procurements is the process of documenting project purchasing decisions, specifying the approach, and identifying potential sellers.

2.0 PROJECT FEASIBILITY STUDY/ANALYSIS

The most important step in any project after a project plan should be determining the viability of the idea. This is called Feasibility study /analysis.

Feasibility analysis also called feasibility study is used to assess the strengths and weaknesses of a proposed project and present directions of activities which will improve a project and achieve desired results. The nature and components of feasibility studies depend primarily on the areas in which analyzed projects are implemented.

Feasibility literally means whether some idea will work or not. It knows beforehand whether there exists a sizeable market for the proposed product/service, what would be the investment requirements and where to get the funding from, whether and where from the necessary technical know-how to convert the idea into a tangible product may be available, and so on. In other words, feasibility study involves an examination of the operations, financial, HR and marketing aspects of a businesson ex-ante (Before the venture comes into existence) basis. Thus, you may simultaneously read this lesson and the lessons on marketing, finance etc. to have a better idea of the issues involved. What we present hereunder is a brief outline of the issues impinging upon the various aspects of the feasibility of the proposed project.

Feasibility is a multivariate concept; that is, a project has to be viable not only in technical terms but also in economic and commercial terms too.

A feasibility study is essentially a process for determining the viability of a proposed initiative or service and providing a framework and direction for its development and delivery. It is a process for making sound decisions and setting direction. It is also a processwhich is driven by research and analysis which usually involves some form of consultation with stakeholders, community, users, etc. that focuses on analyzing, clarifying and resolving key issues and areas of concern or uncertainty which very often involves basic modeling and testing of alternative concepts and approaches.

There is no universal format for a feasibility study. Feasibility studies can be adapted and shaped to meet the specific needs of any given situation.

A feasibility study is designed to provide an overview of the primary issues related to a business idea. The purpose is to identify any "make or break" issues that would prevent your business from being successful in the marketplace. In other words, a feasibility study determines whether the business idea makes sense.

A thorough feasibility analysis provides a lot of information necessary for the business plan. For example, a good market analysis is necessary in order to determine the project's feasibility. This information provides the basis for the market section of the business plan, because putting together a business plan is a significant investment of time and money, you want to make sure that there are no major roadblocks facing your business idea before you make that investment.

In order to identify roadblocks is the purpose of a feasibility study; a feasibility study looks at three major areas:

a) Market issues
b) Organizational/technical issues
c) Financial issues

The elements of feasibility analysis for a project covers the following;

1) Need Analysis
2) Process Work
3) Engineering & Design
4) Cost Estimate
5) Financial Analysis
6) Project Impacts
7) Conclusions and Recommendations

A feasibility report should have the following structure:

1) Executive Summary:

It provides a quick overview of the main points of the assessment, helping to form a picture of the proposal along with the recommendations. It should be concise and include the major findings covered in the main body of the report.

2) Need Analysis

Need Analysis information provide a context to the business proposition. It analyzes the justification of the idea, with a study of possible alternatives. It links the business idea to the current circumstances and helps to inform evaluation of the business idea.

3) Engineering:

Description of the technical aspects of the business idea, including any changes needed to be made to existing processes or the need to add items to existing range of products and services.

4) Cost Estimate:

This involves estimating project cost to a suitable level of accuracy.

- Levels of around -5% to +15% are common at this level of a project plan.

- Estimates of capital investment, recurring and nonrecurring costs must be there

- Sensitivity analysis can be carried out on the estimated cost values to see how sensitive the project plan is to the estimated cost values.

1) Financial Analysis:

This involves an analysis of the cash flow profile of the project

- The analysis should consider rates of return, inflation, sources of capital, payback periods, breakeven point, residual values, and sensitivity

- This is a critical analysis since it determines whether or not and when funds will be available to the project.

2) Project Impacts:

This portion of the feasibility study provides an assessment of the impact of theproposed project.

- Environmental, social, cultural, political, and economic impacts may be some of the factors that will determine how a project is perceived by the public.

3) Conclusions and Recommendations:

The feasibility study should end with the overall outcome of the project.

- This may indicate an endorsement or disapproval of the project.
- Recommendations on what should be done should be included in this section of the feasibility report.

A feasibility study is a management-oriented activity. After a feasibility study, management makes a "go/no-go" decision. It helps examine the problem in the context of broader business strategy.

TYPES OF FEASIBILITY

Feasibility is of the following types:

1) Technical Feasibility:

This area reviews the engineering feasibility of the project, including structural, civil and other relevant engineering aspects necessitated by the project design. The technical capabilities of the personnel as well as the capability of the projected technologies to be used in the project are considered. In some instances, particularly when projects are in third world countries, technology transfer between geographical areas and cultures needs to be analyzed to understand productivity loss (or gain) and other implications due to differences in topography, geography, fuels availability, infrastructure support and other issues.

2) Economic Feasibility:

Economic feasibility is the process of identifying the financial benefits and costs associated with a development project. It involves the feasibility of the proposed project to generate economic benefits. A benefit-cost analysis (addressing a problem or need in the manner proposed by the project compared to other, the cost of other approaches to the same or similar problem) is required. A breakeven analysis when appropriate is also a required aspect of evaluating the economic feasibility of a project.

3) Schedule Feasibility:

How long will it take to get the technical expertise?

- We may have the technology, but that doesn't mean we have the skills required to properly apply that technology.
  - ✓ May need to hire new people
  - ✓ Or re-train existing systems staff

- ✓ Whether hiring or training, it will impact the schedule.

Assess the schedule risk:

- Given our technical expertise, are the project deadlines reasonable?
- If there are specific deadlines, are they mandatory or desirable?
  - ✓ If the deadlines are not mandatory, the analyst can propose several alternative schedules.

What are the real constraints on project deadlines?

- If the project overruns, what are the consequences
  - ✓ Deliver a properly functioning information system two months later
  - ✓ Or deliver an error-prone, useless information system on time?

4) Managerial Feasibility:

Demonstrated management capability and availability, employee involvement, and commitment are key elements required to ascertain managerial feasibility. This addressesthe management and organizational structure of the project, ensuring that the proponent'sstructure is as described in the submittal and is well suited to the type of operation undertaken.

5) Financial Feasibility:

Financial feasibility should be distinguished from economic feasibility. Financial feasibilityinvolves the capability of the project organization to raise the appropriate funds needed to implement the proposed project. In many instances, project proponents choose to have additional investors or other sources of funds for their projects. In these cases, the feasibility, soundness, sources and applications of these project funds can be an obstacle. Asappropriate, loan availability, credit worthiness, equity, and loan schedule still be reviewed as aspects of financial feasibility analysis.

Also included in this area are the review of implications of land purchases, leases and otherestates in land.

6) Cultural Feasibility:

Cultural feasibility deals with the compatibility of the proposed project with the cultural environment of the project. In labor-intensive projects, planned functions must be integratedwith the local cultural practices and beliefs. For example, religious beliefs may influence what an individual is willing to do or not do.

7) Social Feasibility:

Social feasibility addresses the influences that a proposed project may have on the social system in the project environment. The ambient social structure may be such that certain categories of workers may be in short supply or nonexistent. The effect of the project on the social status of the project participants must be assessed to ensure compatibility. It should berecognized that workers in certain industries may have certain status symbols within the society.

8) Safety Feasibility:

Safety feasibility is another important aspect that should be considered in project planning. Safety feasibility refers to an analysis of whether the project is capable of being implemented and operated safely with minimal adverse effects on the environment.

9) Political Feasibility:

Political considerations often dictate directions for a proposed project. This is particularly true for large projects with significant visibility that may have significant government inputs and political implications. For example, political necessity may be a source of support for a project regardless of the project's merits. On the other hand, worthy projects may face insurmountable opposition simply because of political factors. Political feasibility analysis requires an evaluation of the compatibility of project goals withthe prevailing goals of the political system.

10) Environmental Feasibility:

This is an aspect worthy of real attention in the very early stages of a project. Concern must be shown and action must be taken to address any and all environmental concerns raised or anticipated. This componentalso addresses the ability of the project to timely obtain and at a reasonable cost, needed permits, licenses and approvals.

11) Market Feasibility:

This area should not be confused with the Economic Feasibility. The market needs analysisto view the potential impacts of market demand, competitive activities, etc. And market share available. Possible competitive activities by competitors, whether local, regional, national or international, must also be analyzed for early contingency funding and impacts on operating costs during the start-up, ramp-up, and commercial start-up phases of the project.

3.0 PHASES IN LIFE CYCLE OF A CONSTRUCTION PROJECT

Every individual involved in the process of planning, designing, financing, constructing and operating physical facilities related to the project under consideration, gain different viewpoints on project management for construction. The contribution of proficient knowledge can be very beneficial, mainly when it comes to large and complicated projects, since experts in various specialties can offer valuable services. On the other hand, it is very important and advantageous to understand how the different parts of the process match together. The poor coordination and communication between the specialists can result in waste, excessive cost, and delays. It is chiefly the requirement of the owner to assure that such flaws do not happen between them. And it owes all participants involved in the project to regard the interests of owners, as at the end, it is the owners who provide the resources and make the decisions. Implementation of owner's viewpoint will help the participants to focus on the completion of the project by having proper attention in the process of project management for constructed facilities. This would minimize the old concept of bringing decisions based on the historical roles of specialists involved in the project. Specialists mentioned are the planners, architects, engineering designers, constructors, fabricators, material suppliers, financial analysts and others. It is true that each specialist individually has a lot of contribution to the advances seen in the construction field. But the understanding of the entire process of project management will make them respond more effectively to the owner's desires. Hence, they can contribute their

proficiency through opinions in improving the productivity and quality of their work. Enhancement of project management boosts the construction industry which in turn facilitates the development of national and world economy. To have significant improvements, know the construction industry, its working environment and the institutional constraints affecting its activities and the nature of project management.

Construction Project Life Cycle

The purchase of a constructed facility is a major capital investment. The owner can be an individual, a private corporation or a public agency. As the commitment of resources for such a large investment is stimulated by market demands or real needs, the facility is likely to satisfy certain objectives. These requirements will be within the constraints of the specified owner and applicable policies. Most of the constructed facilities are custom made in consultation with the owners, with an exception in the case of the residential units that may be sold as built by the real estate developer. He is regarded as the sponsor of building projects, so far as government agency may be the sponsor of a public project and turns it over to another government unit upon its completion. For project management, the terms "owner" and "sponsor" are one and the same because both have the ultimate power to make all important decisions. It is judicious for any owner to have a clear understanding of the acquisition process to sustain firm control of the quality, timeliness, and cost of the completed facility, as he is essentially acquiring a facility on a promise in some form of agreement. The project life cycle for a constructed facility may be represented schematically in Figure 1. A project meets the market demands or requirement on a timely basis. a variety of possibilities may be taken into consideration in the conceptual planning stage. Hence the technological, as well as the economic feasibility of each option, will be assessed and compared to select the best possible project.

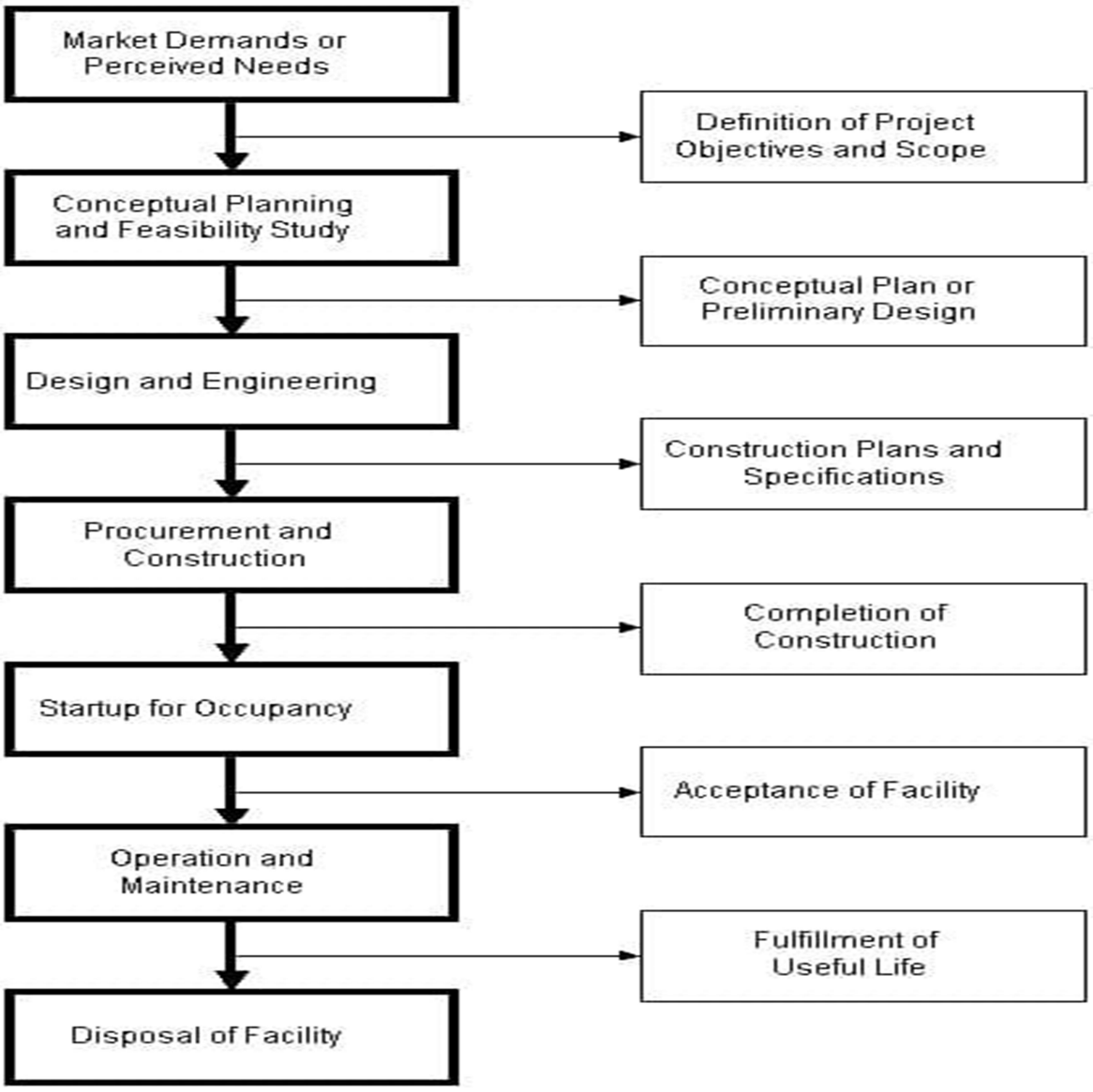

Fig.1.The Project Life Cycle of a Constructed Facility

The financing strategies for the proposed options and ideas should undergo a clear examination, which is later programmed with respect to the timing for project completion and based on the cash flow availability. Once the scope of the project is clearly explained and defined**,** thorough engineering design will provide the blueprint for construction, and the definitive cost estimate will provide the baseline for cost control. Careful planning and control during the procurement and construction stage, the delivery of materials and the erection of the project on the site has to be maintained. Once the construction is completed, there is usually a brief period of start-up of the constructed facility when it is first occupied. At last, the management of the facility is turned over to the owner for full occupancy until the facility lives out its useful life. That is to check the building durability once the functionality is started. If the building cannot show any defects before the period specified, it was chosen for demolition or conversion. The stages of development may not be strictly sequential as

shown in figure-1. Certain specific stages require iteration, and the others can be carried out in parallel or in overlapping time frames. This decision mainly depends on the nature, size and urgency of the project. Moreover, an owner may gain house capacities to handle the work in every stage of the entire process. If it is not possible they may request professional advice and services to guide the work in all stages. Reasonably, most owners choose to handle some of the work in-house. To guide other components of the work, they give the contract to outside professional services as per requirement. Analysis of the project life cycle from an owner's perspective would help us to focus on the proper roles of various activities and participants in all stages apart from the contractual engagements for different types of work.

3.1 THE PHASES OF AN ENGINEERING PROJECT

Engineering projects come in many shapes and sizes, but they can generally be broken down into the following phases.

1. **Planning / Preliminary Engineering.**

This is the stage at which the options are considered and the pros and cons evaluated. Most engineering projects involve the creation of a new product or the destruction and re-build of an existing one, and the project is defined on that basis. The options for the new product can be evaluated based on cost, quality, satisfaction in meeting the engineering criteria, etc. Usually some sort of criteria is established at the beginning of the project that can be used to guide project decision making.

2. **Detailed Design.**

Once the exact product is chosen, detailed design can begin. The end result is usually a set of drawings and/or a tender package. At this stage all of the issues are investigated and a complete engineering analysis is performed.

3. **Tendering.**

During this phase the project is put out to tender. This phase includes advertising, answering of bidder questions, holding pre-tender meetings, and opening of the tenders.

4. **Construction / Implementation.**

This phase involves the physical implementation of the work that the engineer has designed. The engineer’s representative is usually on site because of the engineer’s responsibility to ensure adequate construction of the work, particularly for items that become concealed like concrete reinforcement. Also, since the engineer is more concerned with the suitability of the final product

from an engineering standpoint, there are usually constructability issues that require addressing.

5. **Post-Construction.**

Once the product is complete, the final documentation phase is required to ensure that stakeholders have the documentation they need and project funding and administration issues are finalized.

3.2 PHASES OF CONSTRUCTION PROJECT MANAGEMENT

Every Construction Project, from the small bathroom renovation to the towering skyscraper, has a similar process. Each project requires planning and design. You also need to consider inventory, resources, and manage supplies, the actual construction of the project needs to be managed, and there will be post-construction details to tie-up.

Every construction project, regardless of size, benefits from a solid plan and a great project manager who is familiar with construction project management. To build the right plan for your construction project it is helpful to understand the construction process.

The construction process is the detailed steps required to complete your construction project. This process can be broken down into five phases – planning/design, pre-construction, procurement, construction, and post-construction. Depending on the size and scope of the project, each phase has its own set of challenges.

While construction projects may vary in size, the number of stakeholders, budget, and delivery date, one thing remains certain: Construction projects are always a long and demanding process with lots of moving parts. That is why having the right Project Management Tool at hand is important.

1. THE INITIATION PHASE

The initiation phase is one of the most important aspects of construction project management. It encompasses all of the steps you must take before a project is approved and any planning begins. Usually, there are three different steps in this initial design stage:

- **Programming and feasibility:** The planning team outlines the objectives and goals of the project through a feasibility study or business case. Decisions made at this stage include how large the building will be, how much space will be used, and how many rooms will be needed. Once these decisions are made, a project initiation document (PID) is created.

- **Schematic design:** At this step, the team produces a sketch showing the space as well as materials, colors, and textures. This information will be used during the design development to research the equipment needed and materials to be used.

- **Contract documents:** These documents contain the final drawings and specifications. These documents are used by those placing bids to work on the project.

Common Challenges in the Planning/Design Phase

- ✓ Miscommunication is the biggest hindrance to starting a project off on the right foot. To develop the right design, project managers need to be in touch with the client, designer, architect, suppliers, and engineers. This is impossible without a reliable communication channel.

- ✓ Another big challenge at the first phase of construction project management is undefined goals. Sometimes project stakeholders don't know what exactly they want, or they can't agree on materials. When the goals aren't clear, it's difficult to manage the project.

2. THE PRE-CONSTRUCTION PHASE

When the bidding is completed and the contractor has been chosen to do the work, the next stage of a construction project begins. Before they 'break ground,' as the industry saying goes, the project team is put together. Most commonly, the following team members are included:

- ➢ Contract administrator
- ➢ Project manager
- ➢ Superintendent
- ➢ Field engineer
- ➢ Health and safety manager

At this stage, a project team prepares the construction site before the work begins. The site must be ready for construction, which might mean dealing with environmental issues, such as soil testing. When the site examination is complete, all plans and findings will be reviewed by the city authorities.

Once the strategic plan has been created, and the budget, design, and timeline are finalized, the project team begins to gather the labour and resources required for construction.

Common Challenges in the Pre-Construction Phase

- ✓ A lot of unknown variables can appear if there's no clear picture of what the project is going to look like, how it is going to get done, and when it will be completed. Without evaluating all possible scenarios upfront, the client can have unrealistic expectations. Insufficient preparation increases the risk of issues and hinders your risk management when the project is underway.

- ✓ During the pre-construction phase, there are numerous legal issues, permits, and building codes involved. Without proper paperwork management, documentation storage and control can become another challenge.

3. THE PROCUREMENT PHASE

During this phase, the project team orders, purchases, or rents all the materials, tools, and services necessary to complete the project. This stage of the construction project can be more or less challenging depending on the scope of the project, the resources availability, and the start date.

Common Challenges in the Procurement Phase

- ✓ Miscommunication is one of the most common challenges in this phase. The client might have failed to define their expectations clearly, the contractor faced shipping delays or the wrong product being ordered, and the construction manager gets caught in the middle. It doesn't matter if the project is a living room remodel or a new multi-million-dollar golf club, without transparent, complete information, the project is in danger.

- ✓ Without clear communication for purchasing and inventory management, your staff could be overspending, double-buying, or purchasing outside the project's requirements. This creates even more expense through replacement costs and lost time.

4. THE CONSTRUCTION PHASE

This is the project execution phase where all the planning will pay off. Before any construction begins, the project manager, design, and engineering teams have already put a lot of effort to make a project successful. During the construction phase, the center stage belongs to the contractor and subcontractors.

As the hub of communications for the project, the construction manager and contractor will transition the project into actual construction. The architect, engineers, and project manager perform quality control inspections, respond to Requests for Information (RFIs), and review and approve technical submittals. The priority is to ensure that the project is delivered by the contractor as designed.

Common Challenges in the Construction Phase

- ✓ If the project team has diligently and properly executed the planning and preconstruction phases, construction should progress smoothly. But even with proper planning, there are still challenges. One significant challenge for the Construction Phase is mismanaged scheduling.

- ✓ Poor scheduling is a common challenge at this point. Since most physical construction occurs linearly, one construction team can be waiting for another team to complete their part of the project. Each worker may have their own schedule, too. Without proper scheduling, busy crew members can only guess what activities they should do for the day. Bad planning and scheduling can lead to delays and budget overruns.

- ✓ Lack of communication or missing information can also be a challenge in this phase. Invoices or inventory lists could go missing, revisions to the design or blueprints may not be communicated to everyone efficiently, delays are not managed optimally, there are countless challenges in the construction phase, and most of them are foreseeable and easily rectified with the right software.

5. THE POST-CONSTRUCTION/ CLOSEOUT PHASE

The project closure phase of the project is the last step in the long process of designing and completing a construction project. Now that all the work on the job site has been completed, the project will come to a close.

Project close-out involves more than just completion of the punch list. The resources required for the project are demobilized, equipment rentals are returned, the worksite is cleaned up, and subcontractors that have completed their jobs move onto other projects.

From the project management perspective, it's a good time to carry out a post-project review which could help detect any tasks that weren't completed, analyze any challenges and put together a list of informative insights for the future.

Common Challenges in the Post-Construction/ Closeout Phase

- ✓ Closeout is an essential phase when all the equipment and labor must be managed efficiently to avoid costly delays.

- ✓ Construction projects generate a substantial paper trail. Assembling project-related documentation and getting it in the hands of the owner is one of the final steps of the project management team. Paper-based document management can lead to all sorts of errors and gaps in documentation, so using a cloud-based Document Management System is important throughout the project.

3.3 PHASES OF OIL AND GAS PROJECT IMPLEMENTATION

There are 12 major stages involved in oil & gas projects. Figure 2 specifies all these stages.

Fig. 2: Phases of a Project

1. CONCEPT DEVELOPMENT / CONCEPTUAL DESIGN

Concept development is the first step of the multiphase process involved in creating a new product. For any project or product design process, Conceptual design is the very first stage. The drawings or models are used to describe the proposed product. A set of integrated ideas and concepts are decided in this stage.

Conceptual design is a set of disciplines that contributes to identifying the optimal design at nominal operating conditions of industrial processes/products in the field of engineering.

It evaluates the best design variables and operating conditions to maximize the profit of the organization.

Deliverables of Conceptual Design

- PFD (Process Flow Diagram).
- Functional requirement.
- Process Design.
- HMB (Heat and Material Balance).

Note that the Feasibility Study and Conceptual Design is performed by the Company or Owner

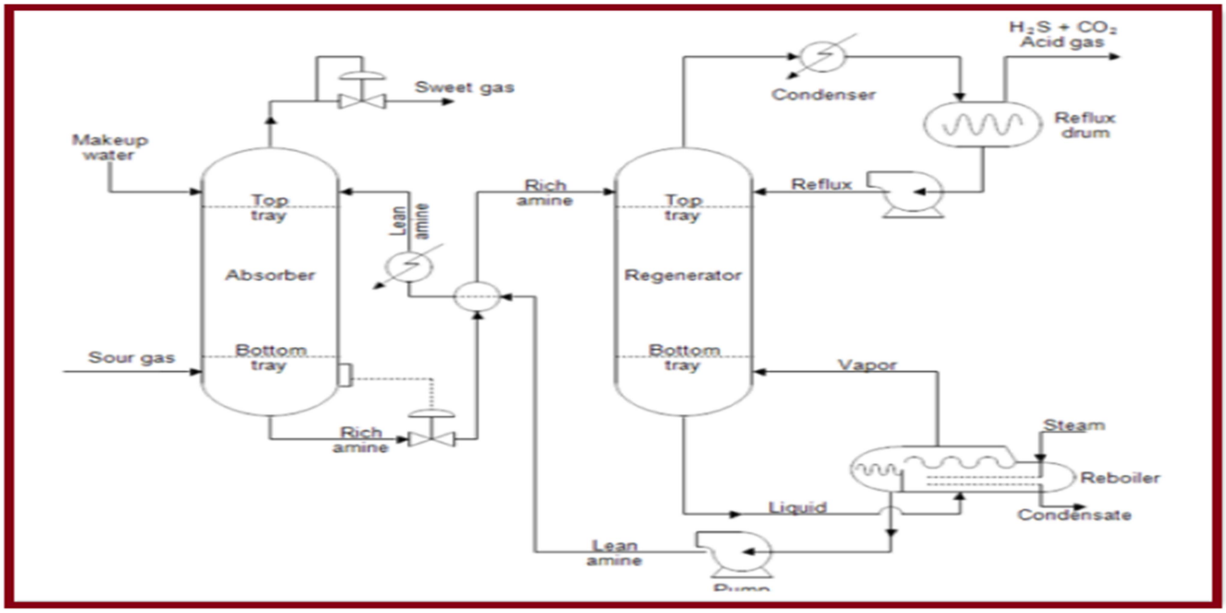

Fig. 1: Sample PFD (Process Flow Diagram).

2. PRE-FEED (PRELIMINARY FRONT END ENGINEERING DESIGN)

Pre-FEED develops the project design basis and places boundaries to constrain and define the concept. This process can be simplified by the following activities:

- A design basis is developed that outlines the operating characteristics of the project.
- The technical and economic feasibility of the design basis will be determined during this

exercise.

- The allocation of additional funds is evaluated for proceeding with engineering and design.
- Project boundaries are developed to deal with rules and regulations, National and local laws, governance, and content issues.

Deliverables of Pre-FEED Stage

- Material selection and specification.
- Plant capacity requirements.
- Product specifications.
- Critical plant operating parameters.
- Available utility specifications.
- Process regulatory requirements.
- All other operating goals and constraints desired by the plant owners/operators/engineers.
- Definition and sizing of main equipment resulting in in-process specifications.
- Preliminary plot plan.

3. FEED (Front End Engineering Design)

FEED or Front End Engineering Design is the most basic engineering conducted after completion of the conceptual design and feasibility study. At this stage, various studies take place to figure out technical issues and estimate rough investment costs.

This work is normally contracted to the EPC (Engineering, Procurement, and Construction) contractors. The final product of this stage is FEED Package. FEED package amounts up to dozens of files and will be the basis of bidding for the EPC Contract. It is important to reflect the client's intentions and project-specific requirements into the FEED Package. It avoids significant changes during the EPC Phase. It is essential to maintain close communication with the client. Sometimes, the client stations at the Contractor's office during the work execution.

Deliverables of FEED

- Final Plot Plan.
- P&ID (Piping and Instrumentation Diagram)
- MDS (Mechanical Data Sheet)
- Line List
- Instrument and Valve data-sheets.
- General Arrangements Drawings for main equipment and main pipework.
- Cost estimating.
- HAZOP Report.

- Project Execution Plan, HSE Plan
- Operational philosophies

4. DETAILED ENGINEERING

Detailed engineering is a study, which creates every aspect of project development. Detailed Engineering includes all the studies before the project construction starts. Detail engineering includes

- the extraction of all the essential information from the basic engineering drawings/FEED
- calculations to provide the exact drawings in detail for the production, fabrication & erection items
- The details of the entire project along with the precise bill of quantities and specifications for each of the equipment.
- It also involves 3D-Modelling.

Deliverables of Detailed Engineering

- Equipment List.
- Process data-sheet.
- Management/review of vendor drawings.
- Thermal rating and vibration analysis of heat exchangers.
- Review of P& ID - Jointly with Client.
- Valve List
- Control valve data-sheet.
- Relief valve data-sheet.
- Detailed piping drawings, including isometrics and stress calculations.
- Bill of Quantity (BOQ).
- MTO (Material Take-off)
- Start-up procedures, Operating and Commissioning manuals.

5. PROCUREMENT PHASE

Procurement involves a series of activities and processes by purchase or procurement team. It is necessary to acquire the necessary products or services from the best suppliers/vendors at the best price and quality. Such products include raw materials, equipment, machinery, instrument, etc.
An effective procurement strategy involves:

- A financial plan to manage the budget.
- A good plan to manage the workflow and production deadlines.

- Keeping everything aligned with the client's objectives.
- Ensuring a smooth supply of required items for construction.

In the oil and gas industry, procurement plays an important role in ensuring the supply of products, items, and services within budget allocation, ensuring on-time delivery on-site and cost savings without compromising quality and safety.

6. PROCUREMENT CYCLE

In Procurement, the Procurement cycle lists the key steps in a cyclical order. This makes an understanding of each procurement step easier. Refer to Fig. 3 for a typical Procurement Cycle with important procurement steps.

Note that Pre-FEED, FEED, Detailed Engineering, and Procurement are performed/executed by the Engineering, Procurement and Construction (EPC) Contractor

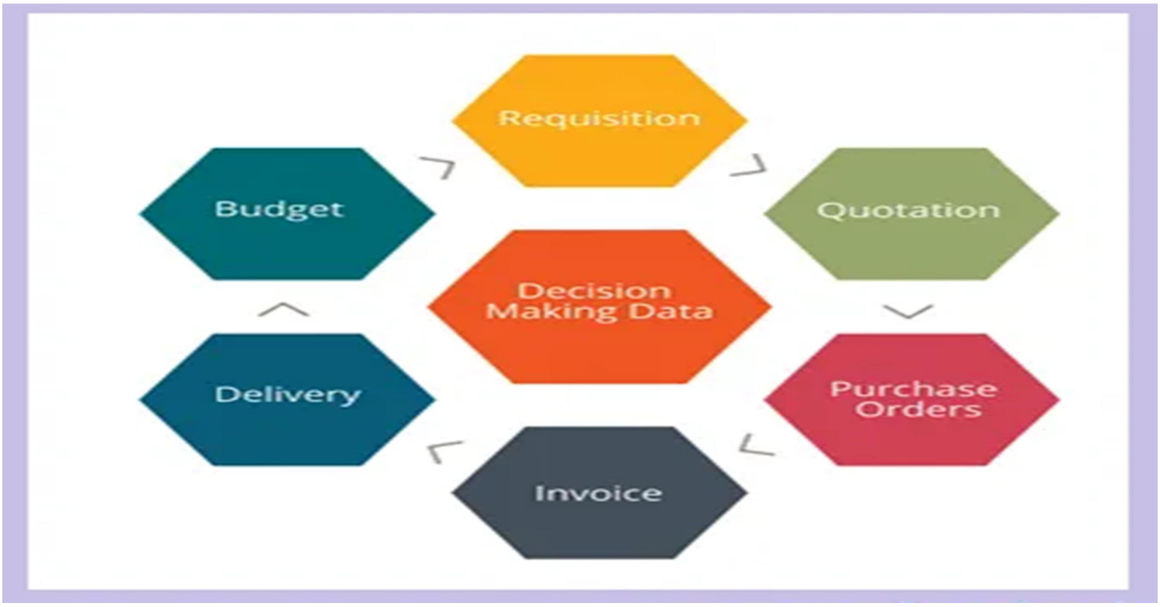

Fig. 3: Typical Procurement Cycle

7. ONSITE AND OFFSITE FABRICATION

Offsite Fabrication is a process of fabrication and assembly of parts or systems at a location away from the project like a workshop. Offsite fabrication provides a cost-benefit, allowing the assembly of units that would not be able to be fabricated on-site due to cost, tooling, availability of resources, or space restrictions. Nowadays it is at a peak in the industry.

Onsite Fabrication is the fabrication held at the project site. After the offsite fabrication, it is still required to do fabrication work at the site for connecting the different pieces of equipment, pipes, and other systems for the installation purpose.

Note: Fabrication is executed by the Contractor/vendors.

8. CONSTRUCTION PHASE

Construction is the activity of putting different elements, objects together. It should follow a detailed design plan, and the installation drawing to create a structure, equipment, building, etc. While constructing large structures/buildings, A clear action plan is a must.

One should know the dimensional coordinates of the specific location. It involves clearing, excavating, and leveling of the land. It also involves other activities associated with the structure, building, and other properties of the plant.

9. ERECTION AND INSTALLATION PHASE

Erection is the process of cleaning and preparing the place of the installation of a new machine or equipment. It involves arranging equipment/elements or the tools for the installation purpose. This is the part of the mechanical completion.

Installation is the process of assembling the different parts of the system by welding or mechanical joint. The process involves connecting the electrical connections for the creation of a single system.

Mechanical completion: The activities involved in the installation of the equipment and piping system is knows as mechanical completion. It is done to make sure everything is installed as per the drawing and after the clearance of this stage commissioning and testing occurs.

Note: Construction, Erection, and Installation are executed by the Contractor.

10. PRE-COMMISSIONING PHASE

Pre-Commissioning activities start after the system achieved mechanical completion. Pre-Commissioning activities include cleaning, flushing, drying, leak test, hydro-testing of the equipment, piping system, and other operating systems. Sometimes pre-commissioning activities are included in mechanical completion but this depends again on the contract conditions or the requirement of the project.

Note: Pre-commissioning & commissioning is executed by the Contractor and the operator of the plant.

11. COMMISSIONING STAGE

Commissioning is a verification process used to confirm that a facility or the process has been designed, procured, fabricated, installed, tested, and prepared for operation or production by the blueprint, design drawings, and specifications provided by the client. It is the second last stage of the project.

Note: After the completion of the commissioning, if no error found in the system then the referred

drawing became an “as-built drawing”.

As-built drawing: This is the final drawing sheet of the plant and used for future modification, maintenance, and review purposes.

12. START-UP PHASE

After successful completion of the testing of the processing system or the plant, it is the time for the green signal to start production.

4.0 TYPICAL PROBLEMS AND SOLUTIONS IN CIVIL ENGINEERING

The Civil Engineer solves problems in a construction site as they arise. They don’t have problems everyday but whenever they occur they solve them. Construction Sites are real challenges for everyone. A civil engineer is a key person that leads paper drawing into real physical things. There are many predictable as well as unwelcome and unpredictable problems in the site. Generally, the civil engineer will not be discussing the site issues with anyone other than the management. If the engineer is civil in their manner, they will be considered favourably. If the engineer is a hothead, no matter whether the engineer is right or wrong, then communication has failed and will take a lot of work to set right. Usually, change orders or variation orders are the problem. Otherwise, things usually go smoothly. Outside of that, there are a million problems from start to finish.

Major Problems a Civil Engineer need to face at the Construction site

The major problems at construction sites are categories below;

1) Health and Safety Problems

There are just so many potential hazards on construction sites, which is why the industry has one of the highest percentages of deaths and lost time injuries! Incidents can cause sites to be immediately shut down and investigated. Rules are different for different jurisdictions, health and safety is the largest risk when managing a construction site. As a result, there will be a health and safety plan which must be adhered to at all times. Due to excessive emission of fugitive dust, some serious health concerns may arise for the workforce and people around a construction site. It definitely impacts the workforce’s productivity, thus, the cost of construction.

2) Environmental Problems

Environmental hazards can also get sites closed down until remedial action is taken. This includes contamination, sediment runoff, and natural disasters. These result from the underlying site conditions, weather, natural disasters, and damage to site controls. Fugitive dust emission certainly

adds up to air pollution, and the chemical used for its elimination isn't also usually environment-friendly. So with every construction, civil engineers have the challenge to prevent it from becoming hazardous to the environment.

3) Contractual Disputes

These can arise for a number of reasons, including variations to the work, damage to property onsite, payment claims, defects in workmanship, etc. It is therefore extremely important for everyone involved to understand everything in the contract before signing and undertaking any work. As a civil engineer you likely have the responsibility of drafting the contract, and making sure work is undertaken accordingly. You will need to approve any variations to the contract and resolve any issues that arise.

4) Government Regulatory Compliance

In addition to the above-mentioned challenges, there are government regulations for site approval, material, transportation, etc. These regulations also have clauses for workforce health & environment.

All the above issues can have significant cost and time implications.