Construction Project Management

A general Review

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Construction project management basics

Project management

Project management is the planning, organizing, staffing, coordinating, directing, and controlling of company resources for a relatively short-term objective that has been established to complete specific goals and objectives (Syal 2007).

Projects are

- Unique
- Temporary
- Have limited time and resources

The Main Project management functions has been defined AS (Helms 2000)

- Planning: Setting goals and determining how to achieve it. Forecasting future.
- Organizing: Developing an organization structure and allocating resources
- Leading: Influencing others to achieve project goals
- Controlling: Is ensuring that performance does not deviate from standards

The Construction Industry (Schexnayder and Mayo):

Characteristics: The construction industry is one of the largest sectors (accounting for about 5-10% GDP in many countries). It is known for involvement of diverse workforce and linked into many other sectors (material suppliers, equipment manufacturers, etc.)

Classification: the construction industry may be classified into the following Areas (Schexnayder and Mayo)

- Commercial
- Residential
- Civil
- Industrial

Players in construction projects (Schexnayder and Mayo)

Owner: have the need for the project, provides financing and decides on scope of work. Owners are either public or private (or public-private partnership). The owner may or may not have in-house construction management departments (have or not have expertise). In the later case the owner may depend on consultants.
Designers: Designers design the project. They may oversee the construction for the owner. Designers; usually lead by an architect; prepare the construction documents, a civil engineer will usually lead the design of civil projects (highways, dams, etc.)
Builders (General Contractors): The party holding a contract with the owner, responsible for managing the project and keeping the project on budget, on time and implemented in a safe manner. The GC usually subcontracts all or portions of the work.
Subcontractors or specialty contractors or trades: subcontractors usually perform portions of the project under a contract with the GC. Subcontractors DO the work. Many subcontractors will be working on a construction project (electrical, mechanical, sanitary, masonry, concrete, etc.).
Trades: trades are the people who implement the work; they are usually employed by the GC or the subcontractors. They may or not be organized in unions.
Construction managers: construction managers are usually construction or consultancy firms involved during both the design and construction process. They may or may not hold contracts with the subcontractors (CM at risk type if involved).
Banks and Insurance companies: builders may borrow money from banks. Insurance companies usually provide bid, performance and payment bonds for builders.
Suppliers: suppliers provide the materials needed for the project. A good relation with suppliers is essential for managing quality and cost. Specifications usually dictate the quality of materials used (based on standards such as ASTM)
Public: The construction industry builds the built environment we live in. the outcome of construction projects and the process itself affects the public directly.

Construction Project Life Cycle

A project goes through a series of phases from its inception to the end. All of these phases are related and each part plays an essential role in the success of a project. The phases may be categorized as follows:

1. **Project planning phase**: after a need for a project is identified the owner begins planning for implementing the project. At this stage the issues are looked at in a broader range gradually adding details. In this phase the following actions are taken:
   - Define the project goals
   - Ensure availability of funds
   - Define owner's requirements (spaces, athletic, quality, etc.)
   - Obtain permits
   - Choose project delivery system
   - Selecting the designer
2. **Project design phase**: During this phase the project is defined through plans, and specifications. The design process is usually headed by an Architect for buildings and a civil engineer for civil works. The design is usually reviewed during several stages (schematic, design, and construction documents). The following are outputs for this phase.
   - The project is designed according to owners goals based on regulations, technical and safety standards (codes)
   - Detailed plans and drawings
   - The designer should make sure the optimum construction documents are prepared that is most ready for implementation
3. **Project bidding and awarding phase**: During this phase contract documents based on the design are prepared. The awarding of the project depends on the project delivery system. In a traditional design-bid-build project the process starts by sending invitation to bidders or publicly advertising for the project.
   During this phase the contractor comes in into the picture for the first time (except for design build projects where the Constriction manager may already have input during the design phase). The owner may award the contract according to these considerations:

   - Price
   - Qualifications and past performance of the bidder

The contractors usually check the following before deciding to bid.

- The market situation and availability of projects
- Availability of cash and staff
- competitors
- .complexity of the project
- Location of the project
- The owner

In the case of deciding to bid the bidders must examine the project in detail, analyzing drawings, specs, prices, location etc. The project is awarded according to standards set by the owner. Public and private entities may be governed by different regulations.

The bid may be managed as one of the following

- Open tender
- Invited tender
- Negotiated

There are several project delivery systems, among them :(Schexnayder&Mayo)(Dorsey-Project delivery methods)(Bonnet)

- Design-bid-build (Unit Price or Lump Sum)
- Negotiated (Cost Plus a fee or Lump Sum)
- Design-build
- Construction Management

4. **Construction phase**: during this phase the ideas and goals of the project which have been defined in the contract documents are built in reality. This phase starts after the selection of a contractor and the issuance of the “notice to proceed” document. The contractor then mobilizes to the site, establishing offices, stores and bringing in necessary services.

   The contractor should implement detailed planning from the start. The contractor usually supervised by a residence engineer is responsible for:

   - Managing for cost, time, quality, scope, safety
   - Coordination with the owner and other parties.

   The project is usually headed by a project manager who is responsible for communication with the owner, directing and

coordinating project work, controlling cost and schedule (time), and providing feedback for the company's management. Among the contractors staff is the project manager, field engineer, superintendent. The owner is usually represented by a resident engineer for technical issues. This phase ends by the project closeout.

Criteria for successful projects

- Adequate lead time
- Complete scope definition and time
- Adequate fees for design and construction
- Complete contract documents
- Careful selection of design and construction practitioners
- Effective prequalification of key contractors
- Adequate preconstruction planning
- Use of partnering
- Effective payment process
- Careful monitoring of schedule and cost
- Minimal change once the work is in progress
- Use of total quality management
- Broadly shared responsibility for safety
- Efficient close-out procedure
- Clear demarcation between construction and maintenance
- Thorough documentation
- Timely follow-up

Contract documents and construction Law

Construction projects are usually defined and bound by a set of documents called the “Contract documents”. An understanding of these documents is essential for all parties. All these documents make part of the contract between the contractor and the owner. These documents consist of:

1. Bidding documents
2. Agreement
3. General conditions of contract
4. Supplementary conditions
5. Drawings
6. Specifications
7. Bill of quantities (or schedule of values)
8. Addenda
9. Site reports (e.g: soil reports)
10. Bond forms

Project managers should be familiar with these documents; each document has a specific purpose that is explained below:

- **Bidding documents**: this refers to the documents included with the bid, among them, invitation to bidders, instruction to bidders, bid form and other information
- **Agreement**: the agreement is the basic document initializing the contract between the owner and the contractor; the other documents are usually referenced here. This document usually mentions the contract sum and the project duration
- **General conditions of contract**: this is a standard document containing rules clarifying rights and responsibilities of the parties. It usually deals with:
    - Definitions (Owner, Engineer, ..) and responsibilities of the parties
    - Scope definition
    - Contract documents definition
    - Staff and Labor
    - Materials and Workmanship
    - Commencement, delays and suspension of works
    - Tests

- Employer's taking over
- Defects and corrections
- Measurements
- Variations
- Contract Price and payments
- Termination of works
- Insurance
- Claims, disputes and arbitration
- Work handover
- Subcontractor's work
- Maintenance

Most countries have standard conditions of contracts of their own. The most common international one is FIDIC's conditions of contract for construction.

- **Supplementary conditions**: are modified or extra conditions added by the owner to the general conditions. These usually take precedence from the general conditions. General conditions of contract have been created to protect the rights of both parties therefore all parties in the contract must be aware of the changes made in the supplementary conditions.
- **Drawings**: drawings describe the contractor's work in a graphic way. They are strongly related to specifications and bill of quantities. Designers must try to minimize conflict between these documents. Contractors must study the drawings very carefully during the bidding and construction process to avoid liabilities.
- **Specifications**: this document describes the quality required for construction items. It may be based on standard nationwide specifications (e.g. Iraqi technical specifications) and may reference other standard documents (ASTM, ACI, AASHTO,etc.). specifications are usually classified as (Justin Sweet) :
    - Design specifications (materials and methods): this part specifies measurements, tolerances, materials, construction methods, quality, and inspection. In short it tells the contractor what material to supply and how to install it. E.g.: how to install chiller pipes, how to insulate, etc.
    - Performance specifications: these specify the output performance required. For example a fire exit door must withstand a fire for a specified period of time; an AC system should cool a place to a specific temperature in a specific period of time.

    - Purchase description specification: this type of specification specifies the type, brand, manufacturer of a specific product or equipment. The specification may list a number of providers for the contractor to select from.
- **Bill of quantities**: unit price contracts are accompanied by a bill of quantities. This describes the work to be done in a quantitative term. Bill of quantities is the base for payments during construction; changes are also examined as per the BOQ. In lump sum contracts there is usually a schedule of values instead.
- **Addenda**: addenda are changes made to the contract documents during the bidding process. It becomes part of the contract and is binding for parties.
- The contract documents may include other documents such as **soil reports**, **bid bond form, performance bond form**

Notes for contractors:

- Study the documents in detail, and show reservation in written if required
- Study conflict between documents and clarify which ones apply
- Look for ambiguous language
- Look for changes made to standard conditions
- A thorough understanding for the rights and obligations helps in defending your rights.

Project cost estimation and control

Efficient estimation and controlling cost is essential for survival of any construction company. A challenge facing most of the construction companies these days is very strong competition which frequently results in low prices (especially in public bids). The most important point for any company is to find a job, a job that is profitable. Thus arises the concern for finding the line that ensures winning tenders but at the same time making profit.

Cost estimation during the bidding process (Contractors point of view)

The procedure for cost estimation during the bidding process depends on the contract type. In lump sum contracts the bidder has to estimate all the elements quantities and price them as well. In this case the bidder should be aware of including all the items in the design, accurately studying the drawings, documents etc.

The most common type of contract in Kurdistan is unit price contracts. In this contract the construction documents are accompanied by a bill of quantities prepared by the owner. The bidder supplies prices for one unit of an item (which will be multiplied by the quantity provided in the owner's BOQ).

The estimation process:

1. The estimator should familiarize himself with all the construction documents by studying drawings, plans, BOQ, specifications and the contract itself.
2. The estimator should study the location of the project and the availability and prices of materials, labor and equipment.
3. The items may be broken down into the following costs as mentioned before
    a. Material cost
    b. Labor Cost
    c. Equipment cost
    d. Subcontracting cost
4. Depending on the market situation and the contractor's situation a decision is made about the profit percentage that will be applied.
5. The bid is rechecked for accuracy and submitted with all required documents and in the time limit set in the invitation to bid document.

The cost of construction may generally be divided into two categories: Direct and indirect cost.

- Direct cost:
  All costs directly related to building items of the structure. (For example all cost incurred directly due to building a wall)
- Indirect Cost:
  Any cost not covered under direct costs, these are usually required for managing work; for example salaries of employees, office cost. Indirect cost is usually a function of time, causing increases in total project cost due to time elongation.

Costs may be divided into five categories:

1. **Material:** A good understanding of materials and material procurement is essential for contractors. In a more globalized economy contractors should be aware of international trade and supply chain. The contractor should usually get quotations from several suppliers. Establishing honest relationships and creating long lasting partnerships is important as well. A suitable method of handling, storing and maintaining materials is also necessary. The contractor may consider the following in estimating material cost :
   a. Quality and specifications required for materials. This may be obtained from the BOQ, drawings and specifications.
   b. The amount of waste that may be incurred for each material. Pre planning and calculation may also decrease amount of waste (for example planning for reinforcement cuts, distribution of sheet metal panels, etc.)
   c. Cost of transportation to the site
   d. Cost of handling and moving material on site (e.g for different storey)
   e. Possible increases in material cost in the long run due to inflation and other considerations (keep in mind that pricing is made during the bid process, and the actual procurement of some materials may not happen until several months or even years later.

2. **Labor:** Labor cost is a major item cost for construction projects. A typical construction building site may have well over twenty different types of construction crews. Labor cost is increasing in a very fast rate in today's construction market in Kurdistan. Labors may be classified as skilled,

semiskilled and unskilled labor. A contractor may have labors who work on a daily wage basis or labors who subcontract part of the work either with materials or without. One of the major issues for labor is labor productivity. The contractor should try to provide best possible situation for labor productivity (even if the labor is working on a unit price basis, still partners making profit are better for all parties). The contractor may try the following to support labor productivity:

a. Organizing workspace for optimum productivity: avoid congestion, minimize material handling distance, suitable lighting,
b. Provide required information and pre planning to minimize rework and repairs. Communicate efficiently
c. Provide a safe environment
d. Minimize any conditions causing low morale
e. Avoid moving crews around. Changing locations reduces productivity
f. Provide efficient supervision
g. Provide required material on time
h. Ensure on time and quality of precedent work
i. Solve disputes
j. Be fair

3. **Equipment:** contractors many types of equipment and tools on jobsites. Advancements in technology and economical development have made these more available. Contractors must become familiarized with the use and maintenance of these. Construction tools on the other hand have significantly increased labor productivity. The contractor may rent or own equipments according to the situation. Road and heavy civil projects like dams usually use more equipment. Point to be taking into considerations
   a. include cost of tools required during the construction process in indirect costs
   b. include cost of equipment such us cranes, material handlers for moving material on site
   c. utilize new technology to increase productivity

4. **Subcontract:**
   Contractors usually subcontract all or parts of the work to subcontractors. The contract may or may not include provision of materials or equipment. Management of labor and subcontractors is one of the main challenging things for general contractors. It should be kept in mind that in design-bid-build projects the owner only has a contract with the general contractor

and the later is responsible for the work of the subcontractors. These points should be taken into account when subcontracting work

   a. Accurately define scope of work to be performed by the subcontractor.
   b. Write down responsibilities of each party in detail (e.g. who provides tools, who pays for scaffolding,)
   c. Establish payment methodology
   d. Coordinate the work of subcontractors efficiently

5. **Other:** this category may include extra cost that cannot be included in the above items; these may include testing cost, survey cost, cleaning, etc.

Estimate one cubic meter of Reinforced Concrete foundation for a single footing

1. Material
   a. Forms
   b. Concrete
   c. Reinforcement
   d. chairs
   e. Ties
   f. Spacers
   g. Curing
   h. Oil for forms
   i. Admixtures
2. Labor
   a. Fixing Reinforcement
   b. Erecting Forms
   c. Opening forms
   d. Oiling forms
   e. Vibrating
   f. Finishing concrete
   g. Curing
   h.
3. Equipment:
   a. Vibrators
   b. Mixers
   c. Pump
4. Subcontracting
5. Other:
   a. Testing
   b. Hot or cold weather protection

Typical Waste Factors for Building Project (Estimating Building Costs, Dekker)

Material type	factor (%)
Precast concrete piles	5
Steel piles	2.5
Wood piles	20
Cast iron pipes	10
Reinforced concrete pipes	6
Corrugated metal pipes	7.5
PVC pipes	6
Vitrified clay pipes	10
Chain link fencing	2.5
Wood fencing	5.5
Ready-mix concrete	7.3
Reinforcing steel bars, light weight, bar #10 and 15	5.7
Reinforcing Steel bars, medium weight, bar # 20 and 25	4
Reinforcing Steel bars, heavy weight, bar # 30 and up	3.3
Formwork	25
Bricks	6
Concrete masonry units	5
Mortar	13
Metal studs	10
Wood	17.9
Plywood	16.7
Fiberboard	16.7
Asphalt roofing shingles	10
Clay roofing tiles	12
Concrete Roofing tiles	15
Roofing felt	10
Built-up roofing	5
Metal roofing	15
Sheet metal—coping, gutter, downspout, flashing	15
Acoustical tile	8
Acoustical board	4
Acoustical panels	4
Acoustical ceiling grid, suspension system	3
Wood flooring—parquet	5
Resilient flooring—tile (vinyl and asphalt)	5
Resilient flooring—sheet (vinyl and linoleum)	10
Carpeting	8
Paint	10

Indirect cost items **(Dagostino and Peterson)**

- Home office overhead costs
  - Office
  - Salaries of office employees

    - other
- Job Overhead costs
    - Employee benefits
    - Site labor
    - Cars
    - Office
    - Computers and copy machines
    - Food & Water
    - Survey equipment
    - Stationery
    - Telephone
    - Cleaning
    - Insurance
    - Performance bond
    - Professional services (design)

Planning and Scheduling

Planning: (Syal)
Definition of Project Planning: Course/Strategy of actions to achieve successful execution of project. It involves answering the following questions:

- What is to be done? (Scope)
- Who will do it? (Human Resources)
- How will it be done? (Methodology)
- When will it be done? (Time Schedule)
- How much will it cost? (Cost estimation and control)

In essence planning is a forecast for future activities and an attempt to perform them in the best interest of the project.
Planning is bringing the future into the present so that you can do something about it now" Alan Lakein
Failing to Plan is Planning to Fail

Why plan?

- A plan is a communication tool between people involved in the project
- Projects are complex, a well thought off plan is necessary to attain optimal cost, time, quality objectives
- A plan is necessary to measure progress, decide on alternatives, take corrective actions
- A plan will establish the basic needs to manage the project,

Scheduling:

Scheduling is a planning tool that shows logic and timing of activities.

Simply put, your scheduling is your work plan for implementing a project, it is your thoughts, strategies, plans, put into meaningful context, it is as good as the effort put into it, a well done schedule will keep you on track while your mind is distracted with all those problems and issues that occur on construction site every day.

- It is not final, until last day
- It tells you where you stand if you put reliable assumptions
- It tells you where to attempt fixing if you are delayed or if you want so
- It is very useful if you integrate it into your construction process administration (ex. When to submit samples to owner, when to start fabrication windows, what to discuss in the next meeting with the owner's rep.)

Why Schedule? :

- Communicate the construction plan
- Establish production goals
- Monitor and measure progress
- Manage change

Creating a Schedule:

On some projects a simple schedule or bar chart is required before bidding; the contractor may put together a bar chart to show that the project will finish within the project duration. If the contractor is awarded the project, then a very detailed schedule is very useful, preferably within the first weeks.

Steps for creating a schedule (AGC)

1. **Define Project Activities**
2. **Estimate Activity Duration**
3. **Establish Relationships**
4. **Run the Schedule, Review and Revise**
5. **Implement and update the schedule**

1. **Define Project Activities**

The first step in creating a schedule is to define the "work" to be done. The work is then divided into manageable pieces of work called "tasks" or "activities". Identifying these activities is the backbone of the schedule and the plan.

A thorough review of the contract documents is essential in identifying the scope of the project and the activities

The contract documents may contain these:

1. Plans
2. Bill of quantities
3. General and special specification
4. General conditions of the contract
5. The agreement

Activity definition: A basic unit of work as part of the total project, that is easily measured and controlled. It is time and resource consuming. Also called task (Mubarak)

Types of activities: (Glavinich)

1. Administration (requests for review, testing, requests for change)
2. Mobilization/demobilization (Office, temporary utilities, stores, access roads, laydown areas, site survey and testing)
3. Procurement (shop drawings, samples, mockups)
4. **Construction** (Site work, substructure, walls, doors, road, finishes, etc.)
5. Start-up and testing (testing of main equipment "chillers, lighting, elevators, etc.)

A technique called Work Breakdown Structure (WBS) is used to systematically identify and organize activities.

Some rules for identifying activities

- The 100% rule, everything that is in the scope of the project should be included in the WBS, i.e. no item is missing

- Divide the work into manageable smaller pieces that you can assign resources to. Use a maximum period of time that should not be exceeded by any activity (say 2 weeks). (activities with long durations are hard to monitor and control)
- Use a consistent format to organize activities so that activities are easily recognized and formatted into groups (ex. Underground work, site work, enclosure, finishes, etc.)

A sample WBS for a construction project may be as follows (Abdelhamid)

1. Project start
2. Site work and utilities
3. Substructure
4. Superstructure
5. Enclosure (Exterior walls and outside finishes)
6. Interiors
7. Procurement
8. Mechanical
9. Electrical
10. Plumbing
11. Project completion

The output of this step is the "Activity List”

2. Estimate Activity Duration

After identifying the project activities, the amount of time required for each activity should be estimated. Mathematically the amount of time depends on the "quantity of work" and the "daily output".

At this stage the scheduler should estimate a certain rate of production and estimate the duration, if the total time of the project does not fit in the duration allowed under the contract, the scheduler should revise the activities and change the durations and/or relationship assumptions.

Duration = Qty / daily output + Contingency

After fixing a specific duration, the result will become a sort of "production goal" for the manager,

How to estimate duration:

- Gather information from previous jobs
- Take into account all required work; don't use only the time required for the "real work" ex. A mason may place 400-600 blocks per day, but you have to account for time spent in erecting scaffold, material delivery, etc. in some areas productivity could be less, such as in high places, walls with difficult shapes, etc.
- Try to get information from skilled labors. Ask direct and accurate questions, (be careful since usually labors give optimistic rates)
- Try to divide up the activity as much as possible (help reduce errors or missing steps)
- Use estimated quantities to calculate duration
- Be careful about items that are new to your experience

3. Establish Relationships

The activities have to be linked together to be able to calculate the total duration of the project. There are four main types of relationships

1. **Finish to Start**: an activity should be finished before its successors could start (activity B can not start until A is finished)
2. **Start to start**: and activity can start when the predecessor has started (B can start when A starts)
3. **Start to finish**: an activity can finish only when it's predecessor had started (B can finish when A starts)
4. **Finish to finish :**an activity can finish when it's predecessor has finished (B can finish when A finishes)

NOTE: B is assumed to the successor of A

The first type is the most common relationship.

Types 2 to 4 are usually used with lags,

Lag: an amount of time "buffer" between two activities

For example: excavation and casting plain concrete of a trench has a start to start relationship with a lag of 5 days, thus plain concrete can start only after 5 days has passed after excavation started.

When establishing relationships consider the following constraints:

- Physical (a slab cannot be poured until the columns are poured)
- Resources (plastering of area B can not start until Area A is finished if there is only one cement plastering crew)
- Regulatory (building permits, reviews, testing, etc.)

4. **Run the Schedule, Review and Revise:** After all the activities are identified, durations set and relationships established the schedule can be calculated. The schedule then can be revised if required.

CPM basics:

Definitions:

Early Start: The earliest possible date the remaining work for the activity can begin. This date is calculated by the project scheduler based on activity relationships, schedule constraints, and resource availability.

Early Finish: The earliest possible date the activity can finish. This date is calculated by the project scheduler based on activity relationships, schedule constraints, and resource availability.

Late Start: The latest possible date the remaining work for the activity must begin without delaying the project finish date. This date is calculated by the project scheduler based on activity relationships, schedule constraints, and resource availability.

Late Finish: The latest possible date the activity must finish without delaying the project finish date. This date is calculated by the project scheduler based on activity relationships, schedule constraints, and resource availability.

Total Float: maximum amount by which an activity can be delayed and not delay the end of the project (Bully float)

Free Float: maximum amount by which an activity can be delayed and not delay the start of its successor (Sensitive float)

Critical path: Path made up of a chain of critical activities (typically TF = 0; zero float convention) that begin with the initial activity and end with the terminal activity. This path defines the longest path in the network resulting in the minimum duration that the project is estimated to take.

Critical Activities: An activity with no floats. Delaying a critical activity delays the project

Non-critical activities: when early and late times of an activity don't match; can be delayed without affecting project completion.

Activities with TF = 0 are Critical (zero-float convention); otherwise activities with min TF are Critical

Forward Pass: successive addition of durations from the start activity to the terminal activity using EF = ES + Duration of Activity

- When a merge node or activity is reached, the maximum EF of the predecessors is used.
- ES of the start activity is assigned to zero

Backward Pass: successive subtraction of durations from the terminal activity to the start activity using LS = LF – Duration of Activity

- When a burst node or activity is reached, the minimum LS of the successors are used.
- LF of the terminal activity is assigned to EF of the project (terminal activity).

AON float calculations

$EF_n = (ES_n + D_n)$

- ES_n=Max. $\{EF_{n-1} + Lag_{(n-1,n)}, EF_{n-2} + Lag_{(n-2,n)}, \ldots..\}$
- $LS_n = (LF_n - D_n)$
- LFn= Min. $\{LS_{n+1} - Lag_{(n,n+1)}, LS_{n+2} - Lag_{(n,n+2)}, \ldots\ldots\}$
- $TF_n = (LS_n - ES_n)$ or $=(LF_n - EF_n)$
- FF_n= Min. $\{ES_{n+1} - (EF_n + Lag_{(n,n+1)}), ES_{n+2} - (EF_n + Lag_{(n,n+1)}), \ldots\ldots\}$
- TF > = FF; IF TF = 0 , FF = 0

5. **Implement and update the schedule**

Using the Schedule:

- A well done schedule is a very useful tool to manage and control your project. It helps you keep track of your project when you get very busy with the nuisances.
- Use look ahead schedules (2 weekly or one monthly) to plan for the activities coming in the following weeks. Make sure all the prerequisites for the activities (material, drawings, space, staff, other resources) are available for the execution of the activity.
- Spot areas with problem (delays, etc.) and take corrective action early.
- Present the schedule in appropriate formats with required information
- How to reduce durations? (class discussion)
    - Increase resources
    - Modify relationships
    - Work over time

- Where to look for change
    - Critical activities
    - Least cost

Updating the Schedule:

Baseline is a complete copy of a project plan that you can compare to the current schedule to evaluate progress.

- Before you update a schedule for the first time, you should create a baseline plan.
- You can compare up to three baselines at one time

Assign personnel responsible for collecting data and assign update cycles.

What data to collect

- Actual Start dates
- Actual Finish dates
- Percent complete

Construction Administration

The management of construction projects involves many parties, relationships, activities to be administered. Project managers should have knowledge and ability to efficiently organize and administer their projects. Below we discuss some of the issues related to construction management administration.

1. **Record keeping**: it is very essential for contractors and the resident engineer to keep detailed records of project related activities. It is preferable to have a standard filing system for all projects. Keeping such a system will make it easy to access information. Some of the record documents are discussed below

    1.1 Daily Report: keep a daily report system to record progress and other conditions. The report may include the following
        - Construction activities status
        - Weather condition
        - Testing operations
        - Labor and equipment used
        - Visitors
        - Materials delivered
        - Construction photos

    .1.2. Testing logs: understand all the testing requirements for different activities. Perform required tests either in lab or on site accordingly. Keep a detailed log for tests undertaken with results.

    .1.3. Submittals: create a logistic sheet for materials to be supplied from the bill of quantities and the schedule. Record all submittals submitted to the resident engineer for approval. Take these points into considerations
        - Some materials may have long procurement time, plan in advance to get them on time.
        - Check if materials procured meet the required quality and specifications
        - Check availability of material in required quantities

2. **Pre construction and other meetings**: Construction meetings are necessary to keep clear communication with all parties. Preconstruction meeting is a meeting held before starting the construction process. It is usually chaired by the project manager. The resident engineer, contractor, major subcontractor attend this meeting. The main purpose of this meeting

is to establish ground rules accepted by all parties. in this meeting the following may be made:

- Introducing parties
- Collecting emails, phone numbers, etc. deciding on means of communication
- Submittal procedures
- Payment procedures
- Change procedures
- Temporary facilities

There may be weekly meetings throughout the construction process. General rules for meetings:

- Prepare meeting notes in advance and send it to participants
- Limit points to be discussed
- Keep meeting notes
- Review previous week's points
- Decide on next week's meeting
- Send written notes to participants after meeting

3. **Measurements**: measuring quantity of work is required for both the owner and the subcontractors. Points to take into account.

   Measured made for owner

   - Prepare in time
   - Use clear drawings, numbering methods, make it checkable by everyone easily
   - Keep in one place
   - Make it checked and signed by Resident Engineer frequently
   - Use standard forms
   - Double check (first on paper, then recheck on site)

   Measurements clause in the Iraqi Conditions of contract

   - The resident engineer does the measuring work
   - The Contractor should provide what is needed for measurement purposes for the resident engineer
   - The measurements is done according to الدليل القياسى الموحد للمسح الكمى لاعمال المبانى و الهندسه المدنيه

4. Payments

The contractor has to prepare payment documents to be reimbursed for works done during the contract. The payment method is different for different kinds of contracts (Unit Price, Lump Sum, and Cost Reimbursement). The most common way of contracting here is Unit price or re measured contracts. The procedure for asking for payments is:

- Work items measured and checked by the resident engineer
- Quantities of work entered into bill of quantities table
- Total work (and may be cost material on site) is calculated
- Payment documents is submitted

Points to consider:

- Understands owner's requirements for payment procedures
- Prepare measurements in advance
- Submit payments on a regular basis "monthly"
- Prepare "Change order" bills in advance to be reimbursed for change work

Iraqi General Condition of contract points (Article 62)

- Payments are submitted each month
- 10% of the amount is retained until it reaches 5%, this is reduced to 2.5% after handing over the works if final measurements are made and the contractor is not indebted to subs or others officially registered with the owner.
- The Resident engineer should certify the payment in no more than thirty days
- Material on site may be included if the Resident engineers finds them acceptable
- A payment does not mean accepting works
- The contractor is not compensated for any payment delays, in case of not accepting the payment in 30 days the contractor and the resident engineer can negotiate on a solution. (in FIDIC the contractor has the right to ask for compound charges , see FIDIC 14.8, Delayed Payment)

5. Safety management

Safety is a growing concern on construction projects. Project managers are responsible for providing a safe working environment.

It should be understood that safety is a “Culture”. In most countries safety requirements are regulated by law and managed by an organization. In the United States the agency responsible is OSHA (Occupational Safety and Health Organization). These organizations has printed regulations, OSHA 1926 is specific for the construction industry. One may get a good understanding of safety requirements by reading these documents.
Sources of safety violations:

1. Scaffolding
2. Fall protection
3. Excavations
4. Ladders
5. Head protection
6. Hazard communication
7. Electrical (wiring methods, design and protection)

Basic Safety procedures

- Have a safety plan
- Keep the site clean and organized
- Check for “danger” areas
- Spread the culture of “Safety” by educating all parties

6. Quality management

Quality is defined as the characteristics of a product or service that bear on its ability to satisfy stated or implied needs. In simple words quality is achieving what is promised. Quality does not necessarily mean the best; it simply means achieving what is specified.
During construction quality is the responsibility of the contractor. Contractors should have a quality control plan in place.
One should separate between two levels of quality:
Contractor Quality Control: is to assure that the project is completed according to the contract quality requirements

Government “Owner” Quality Assurance: is to assure through reviews, inspection and testing that the Contractor’s quality control is working effectively.

Elements of a quality control plan:

- Submittal procedures
- Testing Procedures
- Fixing Deficiencies and rework procedures
- Procedure for performing work
    - Preparatory phase

- Initial phase
- Follow-Up phase

- Inspection procedures

7. **Change management**
   Change is inevitable during every construction process. But incomplete construction documents are prone to lot of change. Owners have the right to ask for change, which may be addition, deletion or modifying part of work. An approved change order becomes a part of the contract.

   - Get written orders for change, oral communication carries risk
   - Clarify who has the right to issue change orders
   - Ask specifics of required change
   - Make detailed estimation for price negotiation (add overhead, profit, etc.)
   - Negotiate extra time required
   - Create log for change orders
     Iraqi General Condition of contract points (Article 52&53)
   - The Engineer has the right to order changes in the work (change type, decrease quantity, increase quantity, .
   - The impact of these changes should considered in terms of cost and time
   - The contractor should not implement any change without a written order from the Engineer
   - The contractor should notify the Engineer about increases in amount of work before proceeding with construction of that item
   - Pricing will be done according to article 53

8. **Job site organizing (Mincks and Johnston, Thomas, Michael and Horman)**:
   A well prepared job site layout can increase labor productivity, decrease waste, and may improve safety as well.
   Jobsite layout plan (Mincks and Johnston): Is a plan for temporary facilities, material movement, material storage, and material handling equipment on the jobsite. This plan includes the following:
   - Jobsite space allocation (Areas for temporary offices and facilities, storage, material delivery)

- Jobsite Access: access to and within the jobsite, forklifts, cranes
- Material Handling: material movement within the site vertical and horizontally
- Worker transportation
- Temporary facilities: offices, storage, sanitary, water, power
- Security
- Signage and barricades: protection of the public from construction hazard

  A good jobsite layout plan minimizes:
  - Labor movement (increasing productivity)
  - Material movement (decreasing cost of equipment moving material, decreasing possibility of breaking)

Points to consider

- Move material with least expensive labor
- Deliver material as close as possible
- Deliver material with delivery people
- Deliver from truck to installation location
- Avoid moving material more than once
- Select the optimum equipment for moving material
- Organize storage area
- Establish sub areas for different materials (reinforcing steel, cement, etc.)
- Sort material as it is unloaded
- Allow space for waste material
- Protect storage material as needed
- For labors:
  - Minimize travel time from gate to worksite
  - Minimize travel time to sanitary facilities
  - Travel time to moving material
  - Travel to ask questions

9. **Time delays (Gibson, general condition, impact of change,**

Time management is one of the main responsibilities of a project manager. The project duration is usually defined in the agreement. The duration will be calculated either in calendar or working days. Construction projects are very prone to time extensions and delays.

Careful planning and control should be used to minimize delays. The project manager should plan for the whole project and individual activities in advance. Anticipate problems and have realistic assumptions. Time delays cause

- Extra indirect cost through overhead and administrative costs
- Decreasing morale
- Contractor's cash tramped in one project
- Bad reputation
- Less new projects
  To be compensated for time delays contractors should
- Keep detailed records of delay causes (e.g. change orders, weather conditions,)
- Claim and get compensated for changes and any other issues caused by the owner

  Iraqi Conditions of contract:
- Articles 41 Temporary suspension of works:
  - The contractor must suspend works based on a written order from the engineer
  - The owner should bear extra costs "if existed" due to this suspension. The contractor should submit a formal request for compensation within thirty days of the suspension order.
  - After ninety continuous days of suspended work the owner and the contractor should negotiate on restarting the work or finding a new way of performing the works
- 45 Time Extensions: the contractor may ask for time extensions for
  - Any change in quantity or quality of work that prevents finishing works on time
  - If the works were delayed for reasons belonging to the owner or other contractors working for him
  - If the delay was due to extraordinary circumstances that could not be forecasted or avoided by the contractor
  - In all the above cases the contractor should ask for time compensation within 30 days

10. Claims and disputes

Often disputes arise during construction. There are established procedures for settling those claims and disputes in the general conditions of contract.

Some basic ground rules (Fisk)

- The documents must be read as a whole
- The document will be construed against the drafter
- The document supersedes all previous discussions
- Specific terms govern general terms
- Documents must be read in the context of the trade
  Things to take into consideration
  - Keep records
  - Be specific with other parties
  - Understand your rights and duties
  - Understand the construction documents
  - Alert the owner of any claims in short time, in written. A delay in doing this may cancel your right
  -

11. Close out

Closing out a project is a challenge for most managers. Many projects stay unclosed well after all construction activities have finished. Planning in advance for the close out is a major responsibility for the manager.

Procedure

- Contractor claims works finished and asks for inspection
- Resident engineer approves claim
- First inspection made by owner and punch list items required for correction given to contractor
- Contractor corrects items
- Owner's final inspection and issuance of certificate of completion
- After the guarantee period ends the contractor gets the remaining 2.5%
- Have a closeout checklist from the beginning
- Finish as much as possible during the construction process (approved measurements, as built, required documents "e.g.test logs"
  Steps to minimize punch list items

- Have a quality management plan in place to minimize deficiencies and correct the existing ones
- Correct unacceptable work immediately
- Correct while subcontractors are still on site
- Make sure required work is done correctly before moving to next activity (fix gypsum plaster cracks before painting)

Iraqi Conditions of contract:

- Article 49
- Article 50
- Article 63
- Article 64

Management skills

Successful managers usually posses a set of skills that are crucial for project management. It is essential for managers to assess their abilities against those skills, and try to acquire them through training and practice. The most commonly recognized skills are:

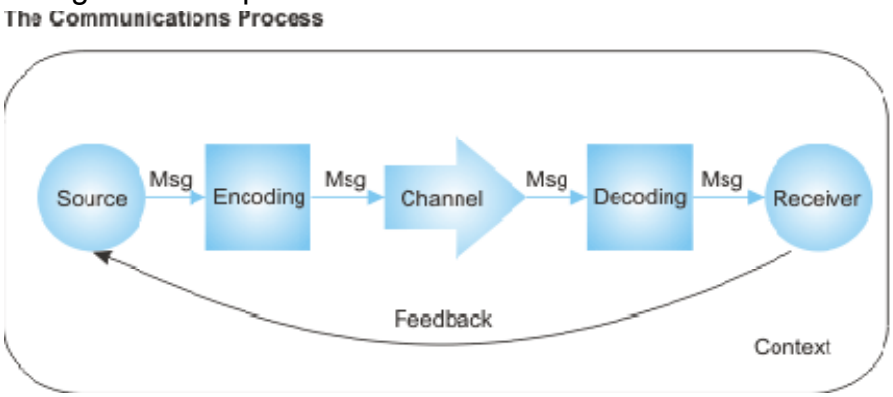
Communication skills

Many scholars regard communication as the most important management skill (Barker).

Definition:

Communication is a process by which information is exchanged between individuals through a common system of symbols, signs, or behavior. (Merriam Webster)

A diagram of the process:



COMMUNICATION BARRIERS (Helms)

Communication barriers (often also called noise or static) complicate the communication process. A communication barrier is anything that impedes the communication process. To have a more effective communication these barriers should be minimized.

Below are some of the most common communication skills

- Conversation skills: conversations are one of the common ways of communication; we do it all the time. To be able to hold effective conversations follow the following steps:

- Clarify your objective.
- Structure your thinking.
- Manage your time.
- Find common ground.
- Move beyond argument.
- Summarize often.
- Use visuals.

Listening skills is a crucial part of any conversation. Managers should improve this skill to be able to gauge their employees, and understand their partners. Some advice for empowering listening:

- Pay attention to the speaker
- Make the speaker feel comfortable
- show and treat the speaker with respect
- encourage the speaker
- obtain accurate information and give positive feedback

o Writing: writing and presenting information is another communication tool. Excellent writing skills are essential to communicate information clearly and precisely, to avoid ambiguity and future claims. Our age is marked by increased use of digital tools, our emails and communication may sit there forever, so care should be taken to write and communicate professionally. Qualities of good writing are:

- Concise
- Compelling
- Clear
- Correct

Remember that besides spoken and written words there are many other communication mediums. A schedule is a powerful communication tool for explaining your plan of action. A budget plan is a communication tool explaining your finances in numbers and tables. In personal contacts paying attention to body language is as much as important as spoken words.

Problem solving skills (john Adair, Helms): construction projects face problems very often, identifying, processing and solving problems is essential for any project manager. Except for routine and small problems, there is a formal step by step approach to handling and solving problems (Helms):

- o Problem Identification
- o Problem Verification
- o Problem Definition
- o Root cause analysis
- o Alternative generation and evaluation of alternatives
- o Implementation and post implementation review

Time management and organizing skills

Project managers are faced with loads of work. To be able to manage your time as a project manager is very essential to have things finished on time. One may try the following to make the best out of their times (Helms):

- Prioritize :
  - most urgent and most important first
  - delegate
- Set goals and control performance
- Delegate work
  - Who to delegate work to
  - Giving clear instructions
  - Giving authority
  - Empowering others
  - Following up on delegated work
- Do not procrastinate
- Plan your work
- Be organized
  - Organize your environment
- Identify your best productive time
  - Perform most challenging work at this time
- Reject work that is not yours
  - Say no to work that is not responsibility
- Minimize time wasters
  - Train yourself to minimize unnecessary surfing of internet, chatting, calls, etc.
  - Do not let be interrupted
- Set time for your personal life

People and Team management (Helms, Lewis, Schermerhorn)

One of the most valuable assets of any company is their employees. Managers should be able to deal with employees, colleagues and customers in the best way.

Helping employees grow throw guidance, training, motivation is one way to win people to your side. Managers should acquire listening skills to help them understand their staff. Leadership skills are one of the best skills to have to direct people and share your organization's vision with them.

Teams are a group of people coming together to accomplish a shared task. Since construction is a collective effort, managing teams and bringing out the best of them is a priceless skill.
The existence of a group of people on a project does not necessarily mean the existence of a team. Project managers should be able to turn the project people into a project team that is coherent, productive and living in harmony. When creating teams take into consideration the following:

- Identify the tasks to be undertaken (your project plan)
- Assess the required skills for the tasks
- Find and train people to be able to undertake the tasks
- Include people with different personalities (the thinker, the detail orientated, the practical)
  When designing a team the following must be clearly outlined (Lewis):
- Define the goals and objectives
- Define roles: what is the duty of each team member?
  - Clearly assign roles
  - Communicate information
  - Encourage members to speak
- Define the procedures
  - How work is done
  - Examine the processes and improve it frequently
- Manage relationships
  - Manage personality issues, jealousy, conflicts, misunderstanding
  - Help team members improve their interpersonal skills

Motivation (Helms, Schermerhorn**)**
Definition: a reason or reasons for acting or behaving in a particular way (Oxford dictionary).
Motivation can be imagined as the force acting on a person to behave in a certain way. Motivated persons can work more efficiently towards a goal. An understanding of what motivates people is important for managers and their organizations to get the best out of their members. Several theories have been proposed to explain motivation. Two main sets have been discussed here. Note that different people and different cultures may have different motivation needs.

- Reinforcement theories: Is the systematic reinforcement of desirable work behavior and the nonreinforcement or punishment of unwanted work behavior. This includes four strategies:
    - **Positive reinforcement**: the administration of positive consequences that tend to increase the likelihood of repeating the desirable behavior in similar settings.
    - **Negative Reinforcement**: the withdrawal of negative consequences, which tends to increase the likelihood of repeating the desirable behavior in similar settings.
    - **Punishment**: is the administration of negative consequences or the withdrawal of positive consequences that tend to reduce the likelihood of repeating the behavior in similar settings
    - **Extinction:** the withdrawal of the reinforcing consequences for a given behavior.
- Content theories: emphasize that motivation comes from individuals needs been satisfied. Among these theories the most well known are:
    - Maslow's Hierarchy of needs theory (physiological, safety, social, self esteem, self actualization)
    - ERG theory (Existence, relatedness, growth needs)
    - Herzberg's two factor theory. This theory indicates the causes of satisfaction and dissatisfaction

Hygiene factors in job context affect job dissatisfaction	**Motivator factors in job context affect job satisfaction**
Organizational policies	Achievement
Quality of supervision	Recognition
Working conditions	Work itself
Base wage or salary	Responsibility
Relationships with peers	Advancement
Relationships with subordinates	Growth
Status	
Security	

High Job Dissatisfaction ← 0 → Job Satisfaction High

Here are some basic tips:

1. Recognize and appreciate other
2. Coach and educate your employees to grow

Negotiation skills (Schermerhorn):

Negotiation—the process of making joint decisions when the parties involved have different preferences.

In any negotiation keep in mind two aspects

- Substance goals (the result outcome of the negotiation): for example a price set agreement on a change, etc.

- Relationship goals: effect of the negotiation on future relationships between the parties. If relationship is important (which is in many cases), this aspect should be taken into account so that damage will not happen to the relationship.

Outcome of negotiations may be categorized as followed

- Win-Win negotiations: in this case all parties come out of the negotiations with satisfaction. All efforts have to be done to keep negotiations in this range
- Win-Lose negotiations: in this case one party wins over the other by the means of authority, power, knowledge, etc. this outcome may hurt the relationships of the parties in future
- Lose-lose negotiations: in this case no one gets what he wants, the problem may remain or it may come to surface again in future in a different way.

  Here are some practical tips (Fisk)

  1. Strive to determine the real objectives of the other party
  2. Do not let personality differences frustrate the course of negotiations
  3. Avoid being too dogmatic or inflexible
  4. List and discuss your side's objectives with all your team members
  5. Be prepared when you begin negotiation
  6. Recognize the consequences of your side if negotiations should fail
  7. Many successful negotiations is easier in a better environment
  8. Maintain a written record of the negotiations on a daily basis
  9. Continually verify the information being presented and received during the course of the negotiations
  10. Never walk out on a negotiation unless you are prepared to terminate it
  11. Patience is virtue, but progress is necessity
  12. Be prepared to make reasonable concessions
  13. Be prepared to turn a disadvantage into an advantage
  14. Quit when you are ahead. You don't always need to knock something off an offer. If the offer is good take it.

Leadership (Helms, John Adair):

A leader is a person who guides and directs others toward a vision**.** While managers are appointed, leadership is excreted, it cannot be given. It is important for managers to be able leaders.
Several theories have discussed the basis of power and leadership, understanding them may help you acquire or strengthen those skills.
Bases of power:

- Coercive power (the power to punish)
- Legitimate power (power based on position)
- Reward Power (Power to reward)
- Referent power (Respect to leader)
- Expert power (Power of knowledge)

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