Course Manual

Nile Basin Initiative (NBI) – Water Resources Planning and Management Project (WRPMP)

Original

SUBJECT SIX (6)

PROJECT SUPERVISION AND CONTRACT MANAGEMENT

FINAL VERSION

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NILE BASIN INITIATIVE
Initiative du Bassin du Nil

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Preface

In order to illustrate the relationships between different Training Topics, we need to go beyond the Project Planning Management framework. The following diagram depicts the Strategic Planning Process where each Training Topic is highlighted by its number order.

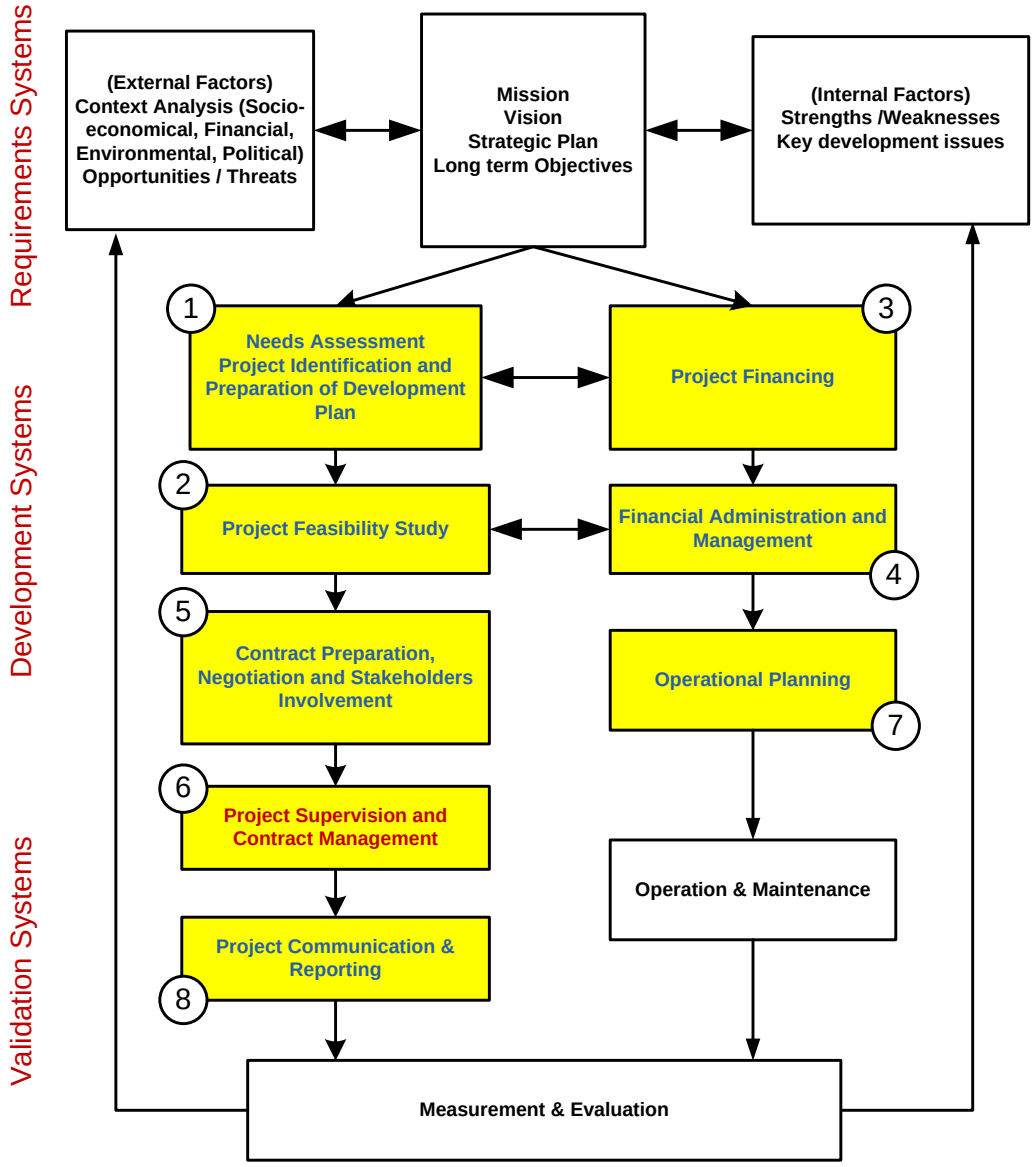


FIGURE A
GENERAL LAYOUT OF THE TRAINING TOPICS WITHIN THE FLOW-CHART MODEL OF THE STRATEGIC PLANNING AND MANAGEMENT SYSTEM

1. INTRODUCTION

A workshop focusing on short introduction in project preparation and management was organized for senior decision makers and senior managers of the Nile Basin Initiatives (NBI) Water Resource Planning and Management Project (WRPMP). Brainstorming sessions on issues associated with difficulties/problems these managers are facing in their project management work environment were held to explore the training topics they consider as the most important ones to be covered in the NBI Project Planning and Management training.

The Project Supervision and Contract Management Manual describes the key processes that could be followed by these senior managers in understanding and effectively carrying out their project supervision and contract management responsibilities in a construction project for the planning, implementation and closing of projects to be carried out under the NBI project. The main purpose of project supervision is to ensure that the project achieves its objectives and, in particular, to work with suppliers and contractors to ensure that the requisite goods and services are procured in the most efficient and economical manner through effective contract management. Specifically, this training manual will deal with roles and responsibilities in work supervision, contract management; and contract arrangements (in reference to FIDIC Guidelines and other accepted Guidelines, e.g., the Project Management Body of Knowledge – PMBOK); performance tracking and cost control; quality management and critical path/time management.

This manual offers NBI senior managers/decision makers a guide to key principles and methodologies to project supervision and contract management focusing on what they need to know. It provides process-by-process guidance to best practices to help them get effective, well-planned mechanisms in place to ensure the success of implementing any construction project.

In preparing this Manual, it has been impossible to cover every detail of the subject. However, the document has been sub-divided to provide fairly self-contained descriptions and guidelines of the different aspects of the subject matters in varying degrees of detailed deemed to be sufficient for the purpose of the Manual.

Chapter 2 describes typical project life cycle and its various phases, including the relationship between the product and project life cycles.

Chapter3 adds a description of project organizational options and their impact on the project team.

Chapter 4 defines the roles and responsibilities of team members relating to the fulfillment of the project goals and objectives.

Chapter 5 discusses one of the fundamental concepts of project management; the triple constraints; and its implications in managing projects.

Chapter 6 covers various contract models associated with contract management practice.

Chapters 7 through 11 provides detailed description of the key project management processes: initiating, planning, execution, control and closing; that could be applied to effectively and efficiently managing contracts to ensure that project objectives are achieved.

Chapter 12 covers project supervision from the perspective of its close relationship with the project execution and performance which is based on an effective project plan.

Effective project supervision and contract management requires a good project plan so that project activity supervision can be properly performed. As can be seen from the above-illustrated Figure A, this can't be achieved without successful implementation of contract preparation, negotiation and stakeholders involvement processes, culminating in a well-defined contract and a proper project plan, a framework for effective project supervision and contract management.

As the main purpose of supervision is to ensure that projects achieve their development objectives and to work with all stakeholders in identifying and dealing with problems that arise during project implementation, a significant and persistent increase in project supervision and contract management activities can lead to an increase in the probability of project success.

2. PROJECT LIFE-CYCLE

A collection of generally sequential and sometimes overlapping project phases whose name and number are determined by the management and control needs of the organization involved in the project, the nature of the project itself and its area of application. These phases provide better management control with appropriate links to the ongoing operations of the performing organization. In general, the project life cycle describes what work is done (and who does the work) in each phase of the project, what the deliverables are for each phase, and approval for each phase. It can be determined or shaped by the unique aspects of the organization, industry or technology employed and provides the basic framework for managing the project, regardless of the specific work involved.

2.1 CHARACTERISTICS OF THE PROJECT LIFE-CYCLE

Projects vary in size and complexity. No matter how large or small, simple or complex, all projects can be mapped to the project management life cycle which includes the five phases of Initiating, Planning, Executing, Controlling and Closing. It can describe what work is done in each phase of the project, what the deliverables are for each phase, and the approval for each phase.

2.2 PRODUCT VERSUS PROJECT LIFE CYCLE

The product life cycle involves the product or service from concept to divestment (closure). This cycle can begin with a business plan, project, transition to operations, and finally the exit or finish of the product or service. Generally, a project life cycle is contained within one or more product life cycle. All projects have a purpose or objective, but in cases where the objective is a service or result, there may be a life cycle for the service or result, not a product life cycle. Since one product may have many projects associated with it, additional efficiencies may be gained by managing all related projects collectively. The project life cycle goes through a series of phases to create the products. Additional projects can include a performance upgrade to the product.

2.3 PROJECT PHASES

Project phases are divisions within a project where extra control is needed to effectively manage the completion of a major deliverable[1]. A deliverable is a measurable, verifiable work product such as a specification, feasibility study report, detailed design document. Project phases are typically completed sequentially, but can overlap in some project situations. For a typical infrastructure project, there are five distinct phases:

2.3.1 THE CONCEPTUAL PHASE (PRE-FEASIBILITY)

The conceptual phase starts upon realization by the authority, public or private, that the investment of capital in the creation of a structure, physical facility, resource development, treatment plant, production facility for the common, specific or particular good. The work of the Conceptual phase, normally carried out by a small team, is composed of the same attention to detail, thorough checking of facts, compilation of data, analysis techniques, planning, setting of objectives, forecasting of results and comparison of scope, quality, cost and time to agreed standards of performance as in the other phases of project work. It is specialized work composed of as many varying disciplines or functions, with many interfaces required between each function.

2.3.2 THE FEASIBILITY PHASE

This phase starts when the client's criteria are achieved. The project appears to be viable, and, it is necessary to check and review the viability so that the client's CEO can obtain the board of directors' approval to fund the project. This phase of the project life is the most important for the ensuing work if it passes this approval. The work at this phase must be done well in the most professional manner, i.e., it will have to respond faithfully to the scrutiny of the highest echelon of company management and perhaps third party funding organizations.

[1] See References on last page.

2.3.3 THE INITIATION/PLANNING PHASE

This is the phase during which the Project Manager prepares the Project Assignment Sheet (PAS); the Project Opening form or the Project Charter(as defined by the U.s. based Project Management Institute); reviews available information and the contract, establishes project objectives, policies, etc. He reviews these with the Chiefs of Disciplines (Civil, Mechanical.), and the project's key managers. The Project Manager plans with his team how they want to accomplish the establishment of the project budget and select key people for the project by working closely with the Chiefs of Disciplines (Functional Managers). A preliminary project planning is then carried out with activities to establish the Scope, Quality, Cost, Time, Resources and potential risks. The result of this exercise should be a relatively "rough" plan for the project. If the resulting Preliminary Project Plan shows that any of the project objectives or resources required are not acceptable, the preliminary planning must be re-done until we are in the " ball park" and get the necessary approvals before we can proceed to the actual, detailed project planning during which we establish in detail, the EPCC (Engineering, Procurement, Construction and Commissioning) objectives and the basis for planning and controlling Scope, Quality, Cost, Time, Risks and Resources.

The details should be detailed enough to have a good planning information. For example, work and manpower control planning should come from the "second level" upwards during this phase. The "first level" details, such as listing each drawing, or each specification can be done to a large degree just before the actual design and drafting activities start. The degree of detail required depends on the size of the project, the importance of the work under consideration, the depth of the information available, and most importantly, the degree of control required. The closer the control of any work, the greater the detail required for planning and subsequent monitoring. The planning phase purpose is to lay the foundation for project execution. A good project plan is a framework for project supervision.

2.3.4 THE EPC (ENGINEERING, PROCUREMENT, CONSTRUCTION) PHASE

This is the phase during which the bulk of the project work is done. It could represent the consumption of most of the project resources in terms of skilled engineering, procurement and construction management and supervision man-hours. The efficiency of this consumption is all important. This is when it shows whether the project team has come up with good project planning and whether the project management approach planned in the planning phase is good.

The Project Manager must be well-alerted. He must know how to delegate properly, but retain his project control staff to analyze, evaluate and forecast the status of the project. He must know his core project team members, and encourage and motivate them all, anticipate their deficiencies, know intimately the methodology, nomenclature, policies and procedures of the company as it applies to the project, achieve results through people. The Project Manager should listen to and rely upon the functional chiefs and the specialists of the product divisions of the company, in their independent review, analysis and

recommendations for project operations. The Project Manager must also be a team builder and support his people for success. It may be good if he has some experience and background in the technology of the industry of the client which he serves. He must be a quick decision maker based upon the best advices available. He must understand the inter-dependencies of the progress of the work in terms of daily decision-making. Much of the Project Manager's time in this phase is spent on planning and controlling of activities and resources. The main project deliverables are completed during this phase.

2.3.5 THE COMMISSIONING PHASE

This phase starts at a time, normally, when the EPC phase is between 80-90% complete (In some cases, for example, the prototype plant, it will start much earlier). Commissioning is a logical, planned, organized and detailed approach to prepare, inspect, test and place a facility into production operation. The commissioning team of the Client, or of the project manager's company is assembled and started its activities of familiarization some months before. The action of the Commissioning team is based on the planning of their phase, which has been done during the EPC phase and must always be involving with the project team. However, should the commissioning manager participate and contribute during the other phases, his work becomes so much easier during this phase resulting in the facility operation will be much better, and attained faster.

The three principal phases of a total commissioning approach are Pre-Commissioning, Commissioning and Start-Up and Plant Operations.

a) Pre-Commissioning: includes all operations oriented activities from project inception to mechanical readiness. The purpose of these activities is to be prepared to commission and operate the facility. Pre-commissioning includes but is not limited to:

   - Role definition with Client, commissioning and operating plans and budgets
   - Establishment of operation and maintenance philosophies
   - Design and model reviews for operability, maintainability and commissionability
   - Audits, procurement of commissioning and operating supplies
   - Preparation of manuals
   - Construction inspection
   - Setting up plant files
   - The recruitment and training of staff

b) Commissioning: includes all the operations oriented activities from mechanical readiness to plant start-up such as:

   - Mechanical readiness inspection with client and contractor
   - Lubrication of appropriate items
   - Dry run tests, static tests, alignments and line flushing

- Correction of deficiency lists
- Dry runs under direction of manufacturer's representative
- Operating under dry run conditions whole systems and plant sections
- All sub systems, plant air, steam water, emergency systems, etc. are operational
- Final commissioning inspection with Client, contractor and engineer where turnover documents are signed by all parties and owner takes over responsibility for the equipment

c) Star-up and plant operations: includes all the operations oriented activities from equipment turnover to full plant operations, such as:

- Introduction of feed materials to the process equipment
- Process and equipment debugging
- Temperatures, pressures and other operating parameters are brought within the theoretical operating ranges
- Final calibrations on instruments, valve settings, feeder adjustments take place

Fig. 1 shows a typical project life cycle of an EPCC construction project.

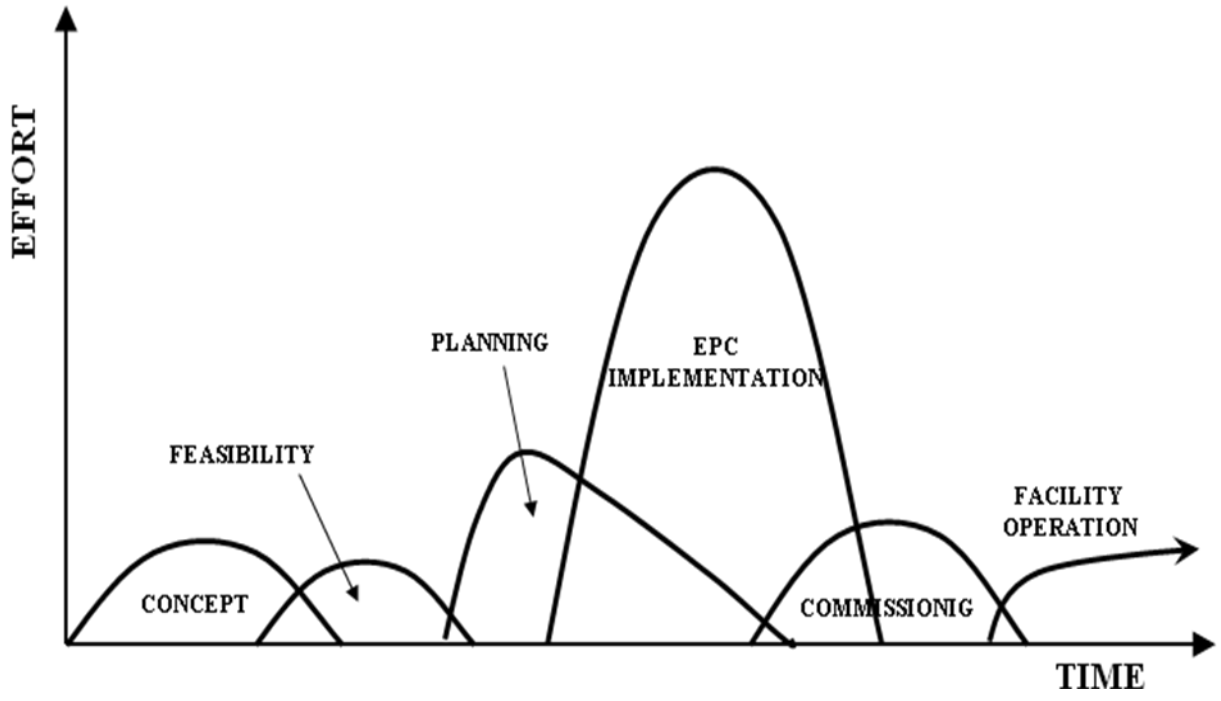


Fig. 1 THE PROJECT LIFE CYCLE

2.4 PROJECT MANAGEMENT LIFE CYCLE

Current practice is being focused on the project management life cycle which includes the five processes of initiating, planning, executing, monitoring & controlling and closing. These processes can be performed throughout the entire project, phase by phase.

Fig. 2 demonstrates how the three life cycles interrelate:

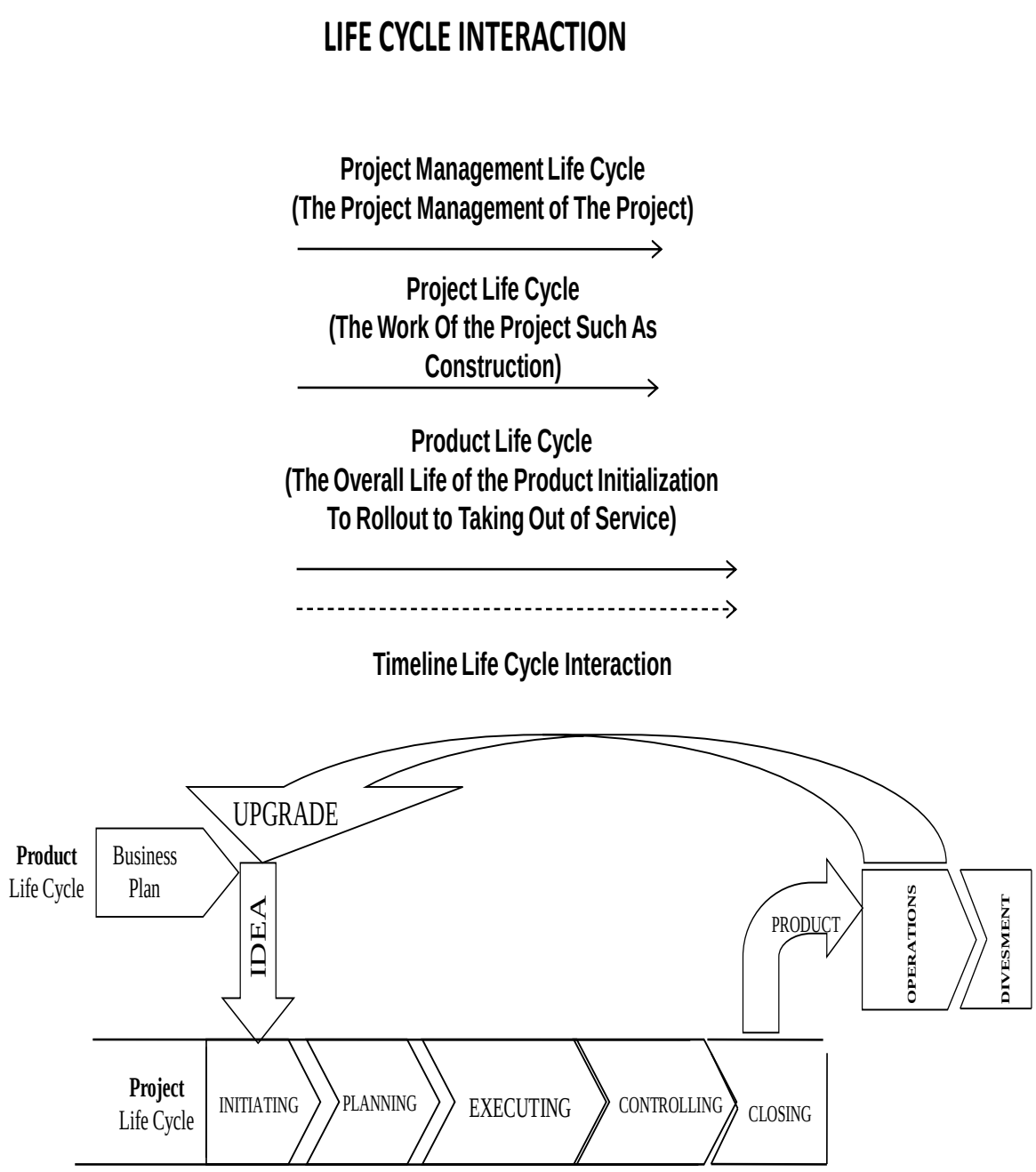


Fig.2 Product/Project Life Cycle Relationship

3. PROJECT ORGANIZATION

3.1 ORGANIZATION STYLES

The paramount objective of senior managers in all corporations and, in particular EPCC (Engineering, Procurement, Construction, Commissioning) organizations devoted to the realization or production of capital investment projects, wherein organization style requires more flexibility are two folds:

- The first is to fully utilize the energy of the human resources to achieve the performance objectives of the project.
- The second, and equally important and it may be the root cause of the first, is to organize the work in an environment with communication and relationships that each person needs for growth. In these major objectives, it must be realized that organization style requires stability and, on the other hand, demands a planned and managed program of organizational development to continually improve performance in meeting these two objectives. The challenge to a company's organization structure is to firstly comply with the demand for detail specialization expertise which is under constant expansion, i.e., to have this immediately available and secondly, to have the capacity to form up project organizations on a rational, planned basis with teams of qualified managerial and technical personnel in the many activities to be performed.

The nature of an organization's structure will greatly determine how a project is managed. In a purely functional organization, the decisions making process and authority will be strongly oriented toward individual departments or functions within the organization, where project managers have little or no influence, authority and decision making power. At the other end of this continuum exists the purely projectized organization, where project managers have tremendous influence, authority and decision making power.

Most organizations' structures are somewhere between these extremes. These are matrix organizations where the decision making and the authority are shared between project management and functional management

Fig.3 illustrates typical matrix organizational project team :

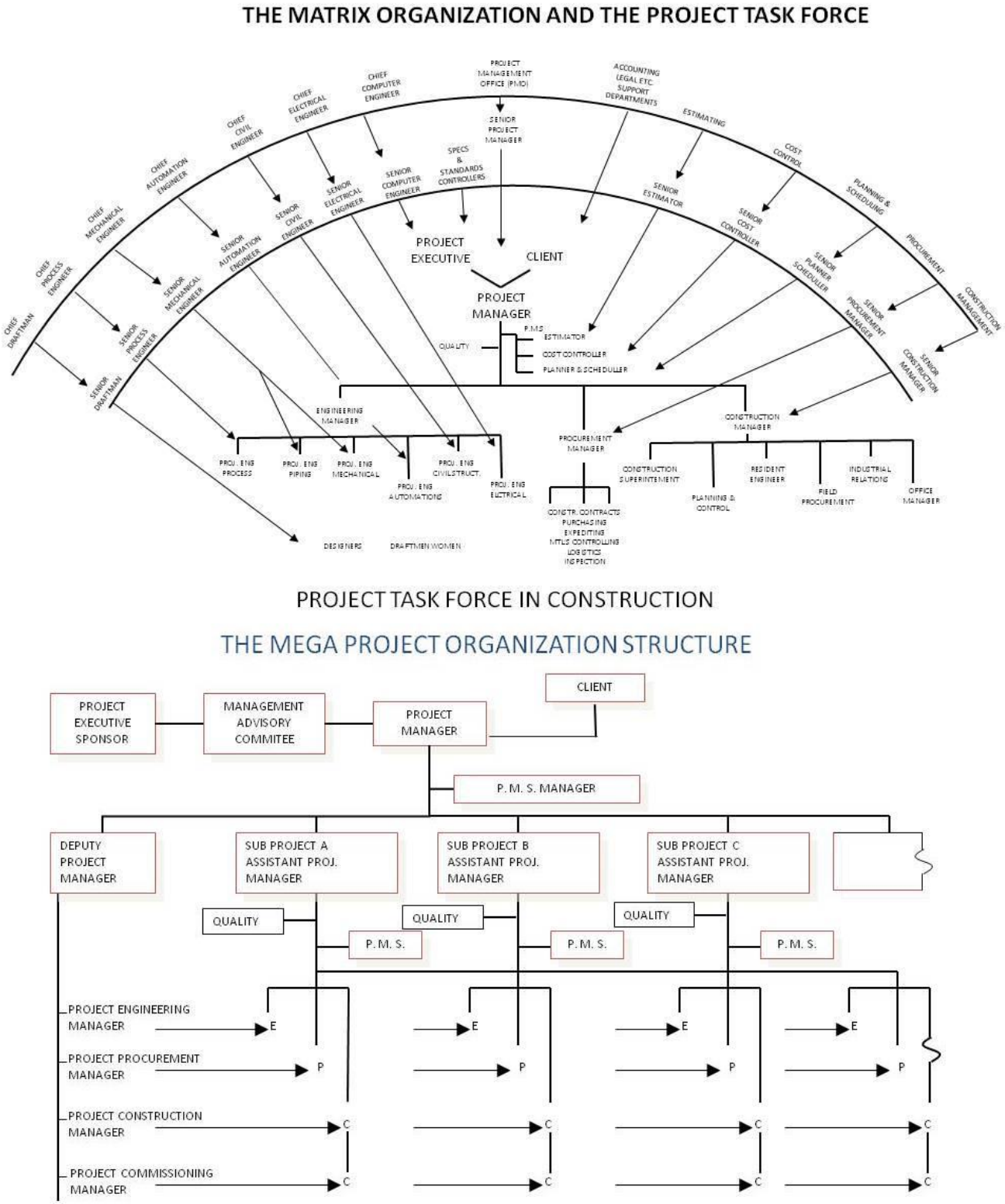


Fig. 3 Typical Matrix Organizational Project Team

3.2 CULTURAL DIVERSITY AND MULTI-COUNTRY IMPACT ON PROJECT TEAMS

As technology allows the world to function as if it were in a single location, the cultural and participative character of project team organization is changing dramatically. A great deal of understanding and learning will be necessary to take advantage of this cultural diversity. The implication for present-day project managers is that they should be aware of the possibility, even the necessity, of having to adapt to unfamiliar, cultural elements of a project in many countries. For example, virtual project teams and multi-cultural teams whose project teams members are from many different countries, are increasing and resulting in a vast array of different approaches to conducting project management. A multicultural understanding, based on the viewpoint of others, is needed.

In addition, globalization is an extremely important factor in today's business because it means new competition for both companies and professionals, domestically and in the home countries of the new contenders. Companies are finding increasing percentages of their markets, and often with higher profit margins, outside their home bases. It also involves competitions in those countries with new stakeholders. Globalization involves the project manager in a position of dealing with people around the world electronically via imaging technology, fax, and telephone. The lack of common languages, cultures, or legal system, as well as the need to work across multi time zones, creates a necessity of understanding the countries where team members originally come from. Hence, the multi-country impact on project team organization is of extreme importance in today's project management environment.

3.3 THE EPCC PROJECT ORGANIZATION

Fig. 4 shows the typical EPCC project organization in a strong matrix environment in which project managers have considerable authority in a project while respecting the project team's relation with the division/unit or office management and with the corporate operations groups. Each individual in the project organization knows his function category and the project functional group to which he/she belongs for his/her performance standards, training development and the company's pursuit of excellence in his functional work. The balance in power and authority in such a two-dimensional managerial matrix structure requires constant attention from the project manager. They show the project organization's relation with the division/unit or office management and with the corporate operations groups.

Every project within the division/unit/office is organized under a project manager who is accountable to the Client and company management for the effective execution, supervision and management of all project activities. For a typical EPC project, the project manager has the following persons reporting to him:

- Project engineering manager
- Project engineers(s) or line or area managers

- Project procurement manager
- Project construction manager
- Project controls manager
- Project commissioning manager (if required)

Personnel to fill the position of project manager, project engineer(s) and project discipline managers listed above are normally selected by the company management in consultation with the Client. Other positions are nominated by heads of discipline in consultation with the project discipline managers.

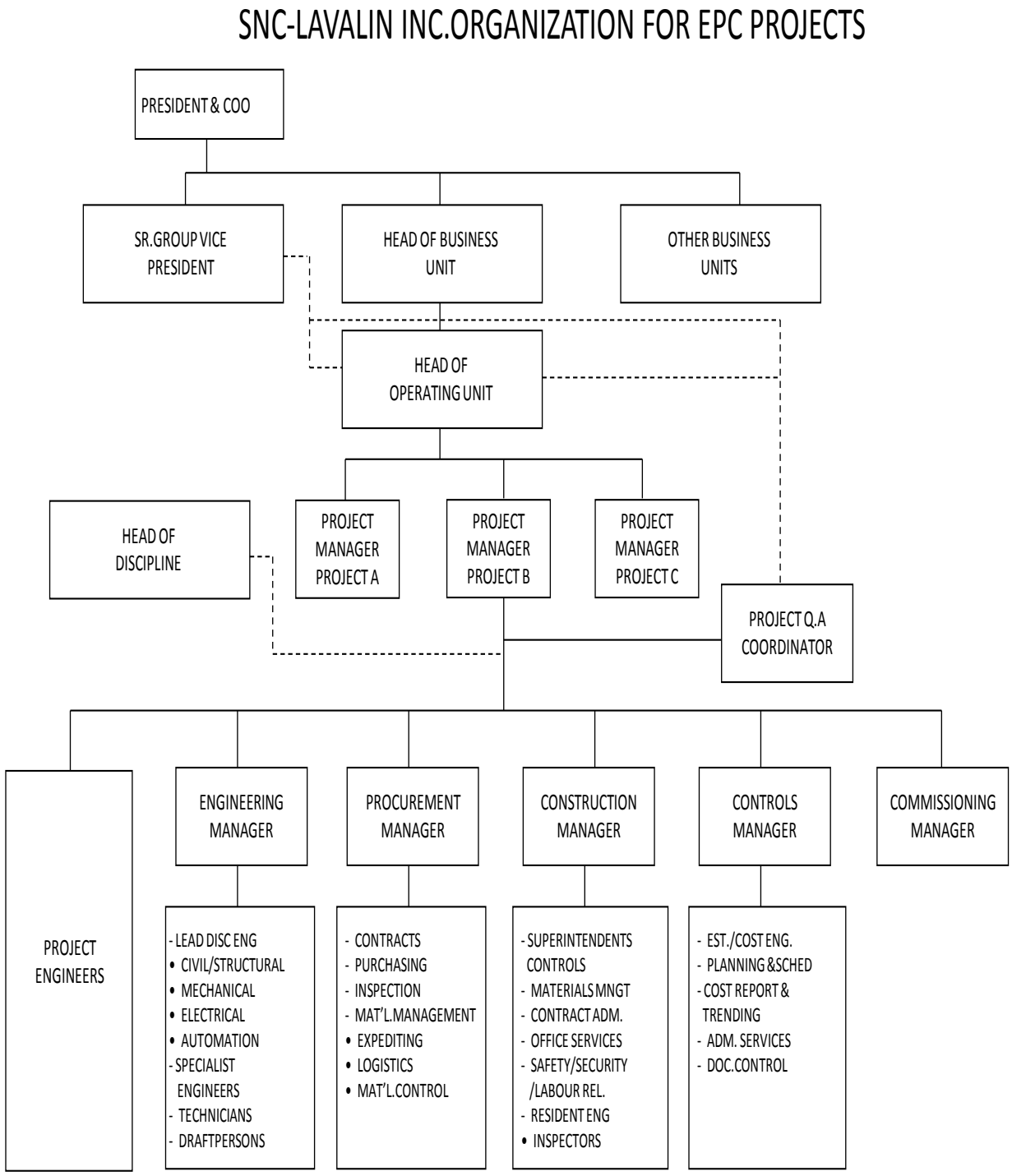


Fig. 4 Typical SNC-Lavalin EPC Project Organization

4. ROLES AND RESPONSIBILITIES (R & R)

Quality in a constructed project is reflected by the performance of project responsibilities in a manner that fulfills the requirements or expectations of each team member through the roles they play in the project team. The role reflects the scope of a project participant's

activities as defined by his/her responsibilities. Project responsibilities is defined as the project objectives to be accomplished by each project participant as defined and assigned by the contract documents, applicable laws, licensing requirements, and professional codes of ethics.

Fig.5 shows the project participant relationships

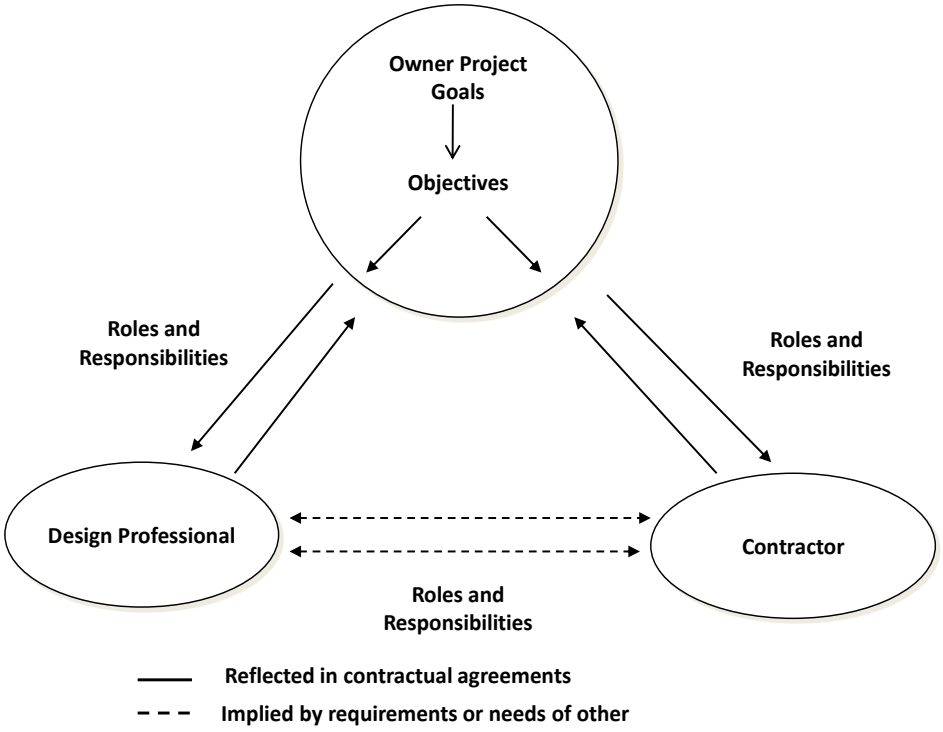


Fig. 5 Project Participant Relationships

4.1 R & R IN PROJECT TEAM'S SUCCESS

The successful completion of any project, in terms of project roles and responsibilities, depends on the followings:

- How well defined and clearly the project goals are expressed?
- How well the goals are translated into specific objectives?
- How clearly the objectives are defined and allocated as responsibilities?
- How fairly and reasonably responsibilities are allocated among project team members?
- How well the team members articulate their requirements to each other?
- How well the team members fulfill their roles and responsibilities to meet contractual and professional obligations?

The project team achieves quality in a constructed project when the project processes and completed facility meet the requirements of the participants and when the participants fulfill their responsibilities to each other.

4.2 KEY R & R DEFINITION FOR A TYPICAL CONSTRUCTION PROJECT ORGANIZATION

Project Manager: A generalist, a team builder and leader, a decision maker with the role to plan and control the interface between the management functional activities. He is the key individual on the project. His job is to successfully implement and complete the project, within time, cost, and quality limits consistent with the scope authorized by the Client. He must have keen leadership, technical and managerial skills, and the ability to get things done right, i.e., the project team must be well directed and motivated requiring leadership qualities and negotiating capabilities. The project manager is the ultimate decision maker.

Controls Manager: The control manager activities include the supervision of Planning and Scheduling, Estimating, Cost Control, Document Control, Computer Services and the administration aspect of the project. The ability of the project manager to manage effectively depends upon the quality and timeliness of the information processed, generated and provided by the Controls Manager.

Discipline Lead Engineer: Each technical discipline is under the supervision of a discipline lead engineer (a chief of discipline) who is responsible for the personnel in his discipline, e.g. Civil, Electrical, that are assigned to the project. His major functions include staffing, assigning personnel to projects, engineering work processes and standards, salary regulation, technical guidance and relocating personnel.

Engineering Manager: The engineering manager activities extend into all aspects of the engineering operation and include technical direction and leadership, production of specification and drawings, management and motivation of design personnel, client relations, quality assurance, planning, procurement, construction and government relations. From a technical perspective, he must insure accurate and sound engineering practices and provide solutions to the real needs of the clients. From an operational perspective, he must be a technical leader, a planner and a coordinator of the efforts of many engineering individuals and groups.

Procurement Manager: The procurement manager activities include the supervision of responsibility to purchase or acquire products, services needed from outside the project team. They include the contract management and change control activities required to develop and administer contracts or purchase orders issued by authorized project team members.

Construction Manager: The construction manager activities include on-site supervision of the planning and control of construction activities on site. Those include planning and

scheduling, estimating the project costs, operations and resources particularly in terms of changes, claims and disputes, cost engineering, site procurement and installation, value engineering, quality assurance, safety and health, labour relations.

Commissioning Manager: The commissioning manager activities include the supervision of a logical, planned, organized, and detailed approach to prepare, inspect, test and place a facility into a productive operation.

Quality Assurance Manager: The quality assurance manager activities include the supervision of a planned and systematic pattern of all means and actions designed to provide adequate confidence that items and services meet contractual and jurisdictional requirements and perform satisfactorily in service. The basic quality actions are inspection, verification, control and assurance.

HSE (Health, Safety and Environment) Manager: The HSE manager activities include the supervision of an effective construction safety and health program to prevent health and safety hazards from happening. Safety hazards are those that pose imminent danger of causing injury or death to workers or damage to materials, equipments or structures whereas health hazards include, among others, heat, radiation, noise, dust, shocks, vibrations and toxic chemicals.

5. THE TRIPLE CONSTRAINTS IN PROJECT MANAGEMENT

5.1 THE TRIPLE CONSTRAINTS CONCEPT

Every capital investment project, whether large or small, is subject to the restraint of three inter-related parameters, Quality/Scope (Performance), Cost and Time, each of which influences, and is influenced by the other two parameters. The objective of Project Management is, first to devise and define, and then to implement a program in which the relationship between these three parameters is optimized, i.e., the desired functional requirement is attained at the lowest practicable cost and in the shortest practicable time.

From the novice to the most experienced and senior project manager, triple constraints issues are at the core of the most crucial decisions about a project. Failure to understand them, interpret them, and exploit them correctly and effectively is enough to doom a project even if all else is done to a high standard of excellence. This is due to the fact that the constraints lead us to that most valuable of project management benefits: the discovery of hidden resources and opportunities within the boundaries set for us in a project. The great secret of the triple constraints is that they are not equally constraining. They exist in a hierarchy of “driver”, “middle”, and “weak” constraint. The driver constraint is the one we have to meet, or else the project fails. The weak constraint, at the other extreme, has the greatest flexibility, and that flexibility gives us opportunity to exploit.

5.2 THE HIERARCHY OF CONSTRAINTS

One of the most powerful secrets of the triple constraints comes from ranking them in the order of their priority and impact on the project. The three terms we use to describe the order of the triple constraints in a hierarchy are:

Driver: The driver is the constraint that can't fail without dragging the project down to failure along with it. The consequence of failure is serious, visible and not excusable by the level of success achieved in the remaining constraints, even if that success surpassed expectations.

Middle constraint: The middle constraint normally has a small amount of flexibility. This constraint can sometimes be very close to the driver in importance to the project mission, almost seeming like a second driver; other times, the middle constraint has flexibility more akin to the weak constraint. In the first case, you will seek almost all your flexibility in the weak constraint; in the latter, you have two to play with.

Weak constraint: The weak constraint is most flexible. It's important to distinguish "most flexible" from "least important", however, because the weak constraint can be of enormous importance yet still possess the greatest flexibility.

Examples of practical situations that proved how an understanding of the principles of the triple constraints and the hierarchy of constraints has given project managers breakthrough insights that have turned projects around:

- **Case #1**: U.S. Manned Lunar Mission, 1961-1969
  - Project Objective: "Land a man on the moon"
  - Time Constraint: "Before the decade is out"
  - Performance Criteria: "and return him safely to Earth"
  - Cost Constraint: To Be Determined

Likely Order: Time/Performance/Cost

Interpretation: Time constraint is the driver as the deadline is not really "Before the decade is out" but rather "before the Soviets get there, or the decade is out, whichever comes first". Performance constraint is the middle constraint as it is difficult to say that the project is a success if it's a one-way trip even though it would be faster and cheaper. It may also be argued that the cost constraint could be described as simply "whatever it takes" although it's probably be the case that a good deal of flexibility lies in the cost estimating of this project, there is ultimately hard budget and/or resource limit that will be imposed.

- **Case #2:** U.S. Superconducting Supercollider Project (Pure Science Product)

Likely Order: Performance/Cost/Time

Interpretation: If the project objective is pure science, time surely can't be the driver. There is no deadline. The quality and completeness of the information is the value we seek, and in the real world there is only so much we can invest in it.

- **Case # 3:** Going to Mars

  Likely Order: Cost/Time/Performance

  Interpretation: What is the reason for going to Mars? Because it's there and we want to discover it. That's a noble enough reason but people are willing to fund that reason-up to a point. When the cost of going to Mars drops sufficiently, or the scientific reason for going there gets stronger, we will go to Mars but probably not before that.

- **Case #4:** Factories in Space

  Likely Order: Time/Cost/Performance

  Interpretation: Economic development is funded in expectation of profit. Assuming that circumstances justified private investment from industries, the time constraint is usually elevated, as the Return on Investment (ROI) number becomes crucial and competition often enters the arena.

5.2.1 EXPLOITING THE WEAK CONSTRAINT

The weak constraint is such a useful tool that it's almost a secret resource for a good project manager. Its flexibility should be considered part of a project manager's strategic reserve, capable of being used in stages of the project from early planning to late risk response, as needed.

There are different ways to exploit flexibility in the weak constraint. The best project managers use the flexibility in a creative way. In addition to being aware of general strategies for exploiting the weak constraint, as shown below, exploit the creative opportunities to maximize the impact.

Weak Constraint	Exploitation Strategy
Time	Use schedule slippage to get out of holes and mitigate risks
Performance	Identify essential, desirable, and optional elements of performance. Plan the schedule so that the essential elements are done first; if the project manager is unable to complete all the rest, he can be sure that he has done those with the highest value.
Cost	Throw money and resources at problems as the best way to solve them.

5.2.2 WHO DETERMINES THE RIGHT HIERARCHY OF CONSTRAINTS?

The triple constraints come out of the basic reason for doing the project and the environment in which the project takes place, i.e., they are derived, not decided. Therefore, neither the customer nor the project sponsor nor the project manager actually decides on the hierarchy of constraints. The correct hierarchy is the one that reflects the real goals and objectives of the project. It's discovered, not decided.

5.2.3 STRATEGIES FOR IDENTIFYING THE CORRECT HIERARCHY

Ask question "Why"

Conduct interviews

Research the story

Compare the consequences of failure or success

Figures 6 and 7 show the Triple Constraints in Project Management and Interpretation.

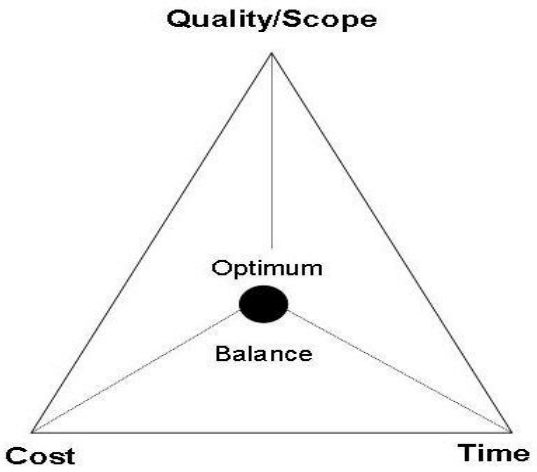


Fig.6 The Triple Constraints in Project Management

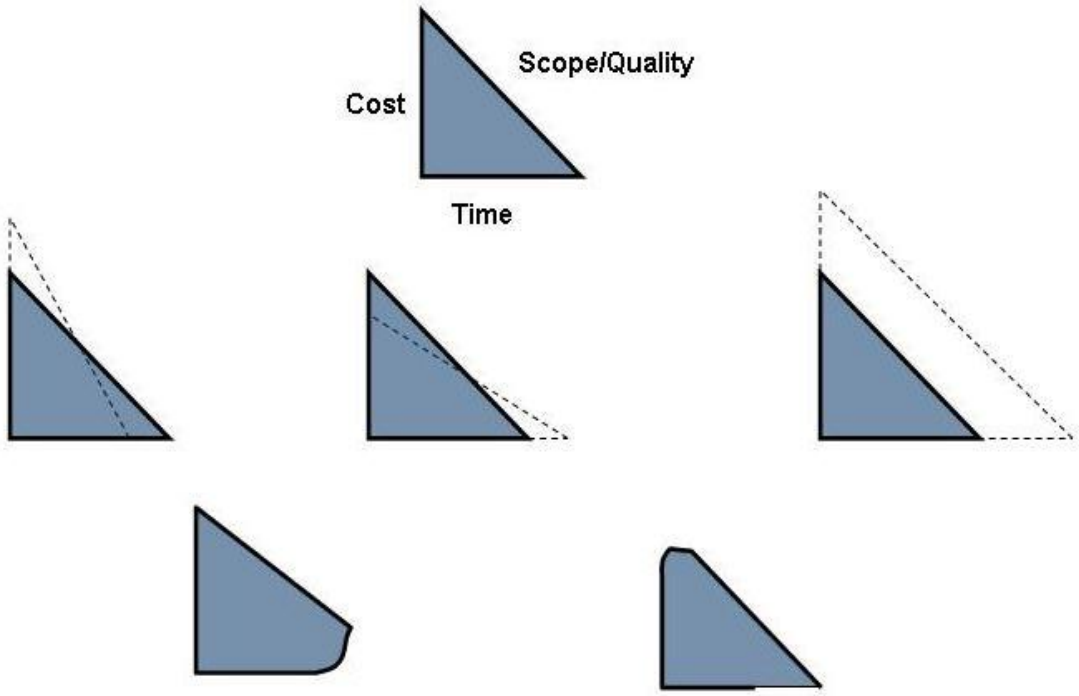


Fig.7 The Triple Constraints Interpretation

6. CONTRACT MANAGEMENT

6.1 THE PROJECT MANAGEMENT BODY OF KNOWLEDGE (PMBOK) GUIDELINES

Contract management include the processes necessary to purchase or acquire materials, products or services needed outside the project team. Contract management includes administering any contract issued by an outside organization (the buyer) that is acquiring the project from the performing organization (the seller), and administering contractual obligations placed on the project team by the contract. The objective of contract management is to secure for each bid package a sufficient number of sellers (bidders), including subcontractors, who are qualified, competitive, interested in the work, and capable of doing the work within the project time and budget requirements. Contract management includes the following activities:

6.1.1 CONTRACT PLAN

The process of documenting project purchasing decisions, specifying the approach, and identifying potential sellers. This is done during the contract planning phase. It identifies those project needs which can best be, or must be, met by acquiring materials, products or services outside the project organization, versus those project needs which can be accomplished by the project team. This process involves determining whether to acquire

outside support and, if so, what to acquire, how to acquire it, how much is needed, and when to acquire it[2] (1).

The contract plan process includes consideration of the risks involved with each purchasing decision. It also includes reviewing the types of contract planned to be used with respect to mitigating risks, sometimes transferring risks to the seller. The contract plan describes how the procurement processes will be managed from developing procurement documents through contract closure.

6.1.2 CONTRACT CONDUCT

The process of obtaining seller (supplier) responses, selecting a seller, and awarding a contract. This is done during the contract execution phase. The project team will receive bids or proposals and will apply defined selection criteria to select one or more sellers who are qualified to perform the work and acceptable as a seller. A short list of qualified sellers can be established based on a preliminary proposal. A more detailed evaluation can then be conducted based on a more specific and comprehensive requirements document requested from the sellers on the short list. The sellers selected are those who have been judged to be in a competitive range based upon the outcome of the proposal or bid evaluation, and who have negotiated a draft contract that will become the actual contract when an award is made. A procurement contract is awarded to each selected seller. The contract can be in the form of simple purchase order or a complex document. Regardless of the document's complexity, a contract is a mutually binding legal agreement that obligates the seller to provide the specified products, materials and obligates the buyer to compensate the seller.

6.1.3 CONTRACT ADMINISTRATION

The process of managing procurement relationships, monitoring contract performance, and making changes as needed. Both the buyer and the seller will administer the procurement contract for similar purposes. Each must ensure that both parties meet their contractual obligations and that their own legal rights are protected[3] (1). This is to be carried out during the project control phase. This process ensures that the seller's performance meets procurement requirements and that the buyer performs according to the terms of the legal contract. The legal nature of the contractual relationship makes it imperative that the project management team is aware of the legal implications of actions taken when administering any contract. On larger projects with multiple providers, a key aspect of contract administration is managing interfaces among the various providers.

6.1.4 CONTRACT CLOSURE

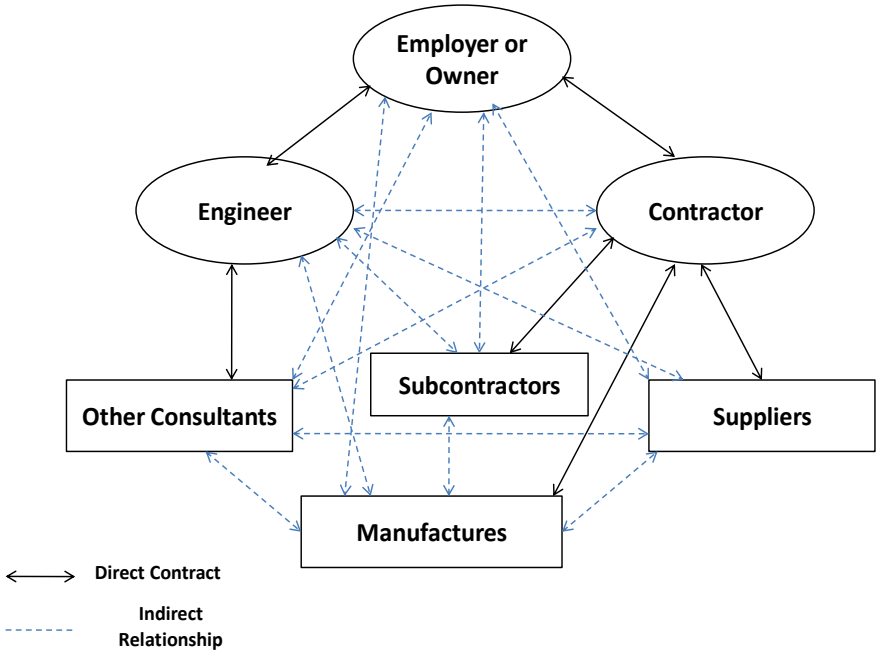
Contract closure is the process of completing each contract. It involves verification that all work and deliverables are acceptable. It also involves administrative activities such as finalizing open claims, updating records to reflect final results and archiving such

[2] See Reference 1 on last page.
[3] See References 1 on last page.

information for future use[4] (1). This is done during the closing phase .Contract closure addresses each contract applicable to the project. Unresolved claims may be subject to litigation after closure. The contract terms and conditions can prescribe specific procedures for contract closure. The buyer, usually through its authorized contract administrator, provides the seller with formal written notice that the contract has been completed. Requirements for formal contract closure are usually defined in the terms and conditions of the contract and are included in the contract management plan.

6.2 FIDIC (THE FEDERATION INTERNATIONALE DES INGENIEURS-CONSEILS) GUIDELINES[5] (2)

FIDIC Contract Management includes a sequence of the Seller (Contractor)'s contract activities to be supervised by the Employer (Buyer) or by his representative, the Engineer, after the parties (the Employer or the Contractor, as the context requires) entered into a contract agreement which must be done within 28 days after the Contractor (Seller) receives the Letter of Acceptance unless they agree otherwise. In the 4th Edition of the FIDIC Red Book, the main parties connected contractually to the Employer or the Owner in the procurement strategy are the Engineer and the Contractor, as can be seen from Fig. 8. The Engineer is usually assisted by suitably qualified assistants who should cover all aspects of supervision, quality control, measurement and other required functions on the site and in the design office.



[4] See References 1 on last page.
[5] See References 2 0n last page.

Fig. 8 Project Participant Relationships

Under the usual arrangements for this type of contract for Construction, the Contractor constructs the works in accordance with a design provided by the Employer. FIDIC contract management involves activities where tenders are normally invited on an international basis. These include:

- **Issue of the Tender Documents**
- **Submission of the Tender**
- **Issue of the Letter of Acceptance**
- **Commencement of Work:** The Commencement Date of the work shall be within 42 days after the Contractor receives the Letter of Acceptance. The Contractor shall commence the design and execution of the work as soon as is reasonably practicable after commencement date, and shall then proceed with the Works with due expedition and without delay.
- **Performance Security:** The Contractor shall obtain, at his cost, a Performance Security for proper performance, in the amount and currencies stated in the Appendix to Tender. If an amount is not stated in the Appendix to Tender, this Sub-Claude shall not be applied. The Contractor shall deliver the Performance Security to the Employer **within 28 days** after receiving the Letter of Acceptance, and shall send a copy to the Engineer. The Performance Security shall be issued by an entity and from within a country (or jurisdiction) approved by the Employer. The Contractor shall ensure that the Performance Security is valid and enforceable until the Contractor has executed and completed the Works and remedied any defects.
- **Application for Interim Payment Certificates:** The Contractor shall submit a statement in six copies to the Engineer after the end of the period of payment stated in the Contract (if not stated, after the end of each month), in a form approved by the Engineer, showing in details the amounts to which the Contractor considers himself to be entitled, together with supporting documents which shall include the relevant report in progress.
- **Time for Completion:** The Contractor shall complete the work, and each section (if any) within the Time for Completion for the Works or Section (as the case may be), including achieving the passing of the Tests on Completion and completing all the work which is stated in the contract as being required for the Works or section.
- **Tests on Completion:** The Contractor shall carry out the Tests on Completion in accordance with sub-clause “Testing”, after providing the documents in accordance with sub-clause “As-Built Documents” and sub-clause “Operation and Maintenance Manuals”.
- **Taking-Over Certificate:** The Works shall be taken over by the Employer when (i) the works have been completed in accordance with the Contract and (ii) a Taking-Over Certificate for the Works has been issued. The Contractor may apply by notice to the Engineer for a Take-Over Certificate not earlier than 14 days before the Works will, in the Contractor’s opinion, be complete and ready for take-over.

- **Tests after Completion:** If Tests after Completion are specified in the Contract, the Employer shall(a) provide all electricity, equipment, fuel, instruments, labour, materials, and suitably qualified and experienced staff, as necessary to carry out the Tests after Completion efficiently and (ii) carry out the Tests after completion in accordance with the manuals supplied by the Contractor under " Operation and Maintenance manuals" and such guidance as the Contractor may be required during the course of these tests; and in the presence of such Contractor's Personnel as either party may reasonably request.
- **Completion of Outstanding Work and Remedying Defects:** In order that the Works and Contractor's Documents shall be in the condition required by the Contract (fair wear and tear excepted) by the expiry date of the relevant **Defects Notification Period**, the Contractor shall (a) complete any work which is outstanding on the date stated in a Taking-Over Certificate, within such reasonable time as is instructed by the Engineer and (b) execute all work required to remedy defects or damage, as may be notified by (or on behalf of) the Employer on or before the expiry date of the Defects Notification Period of the Works.
- **Performance Certificate**: Performance of the Contractor's obligations shall not be considered to have been completed until the Engineer has issued the Performance Certificate to the Contractor, stating the date on which the Contractor completed his obligations under the Contract.
- **Issue of Final Payment Certificate:** within 28 days after the Final statement and written discharge in accordance with sub-clause " Application for Final Payment Certificate" and sub-clause" Discharge", the Engineer shall issue, to the Employer, the Final Payment Certificate.

Fig. 9 shows a typical FIDIC Construction Contract Manager Principle Events

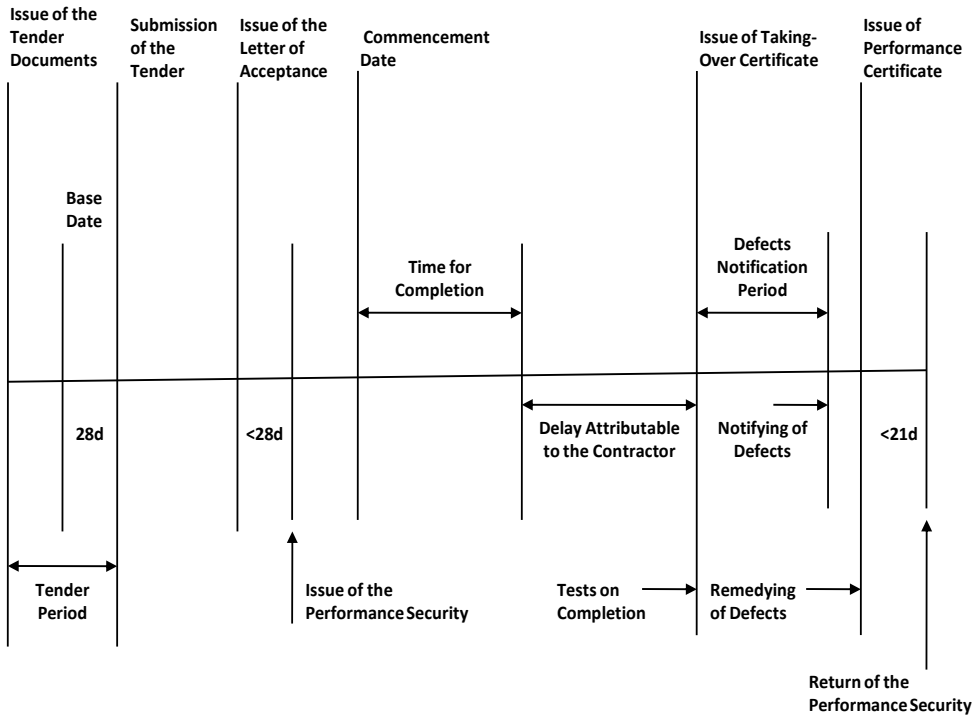


Fig. 9 Typical FIDIC Construction Contract Management Principal Events

6.3 OTHER CONTRACT MODELS GUIDELINES

Owners, Design Engineers, and Contractors make the decisions, provide the services, and perform the work to deliver constructed projects based on various contract models, FIDIC is one of these, which describe how the participants are organized to interact, transforming the Owner's project goals and objectives into a finished facility. When considering which model to be used, the owner considers a number of general but significant factors, including past practices and experience, the advice of consultants, funding sources and constraints, the effective use of project resources and working capital as well as the interests of other project stakeholders. Besides the above-mentioned models discussed, other models such as those mentioned below could be used to reflect the Owner's choice of a contract model to match his/her requirements.

6.3.1 TRADITIONAL DESIGN-BID-BUILD (DBB)

This contract model is effective where the Engineer does not require detailed knowledge of the means and methods of construction. This model provides the Owner with a high degree of control of project activities.

Under the DBB model, the Owner defines project goals and objectives, secures the financing, and specifies the standards and contract terms. The Owner may perform planning, conceptual design, and detailed design, or may engage an outside Engineer

(Designer) for some or all of these tasks. The Engineer then prepares the construction bid documents to reflect the Owner's project goals and objectives. The bid documents should be sufficiently complete, detailed and clear in describing the project objectives. Prospective contractors prepare their bids from the complete and specific bid documents. Each bidder typically evaluates risks and uncertainty to identify potential conditions that could affect cost and schedule.

The bidders submit their proposals to the Owner, who, often with the assistance of the Engineer, determines the most responsive bid. The criteria to select the contractor are usually based on a value-based selection system in which cost is one of several factors considered.

During construction, a member of the Owner's staff, or a member of the Engineer's organization, if designated by the Owner, usually serves as the Owner's project representative. This person shall administer the construction contracts, with responsibilities that include reviewing the contractor's submittals and work for conformance with the requirements of the contract documents and evaluating the contractor's payment application for work completed.

6.3.2 DESIGN-BUILD (DB) MODEL

In the last decade of the twentieth century, Design-Build contracting model became more widespread worldwide. In this type of model, the project's owner contracts for both design and construction from a single entity known as the design-builder. Hence, a single point of responsibility for both design and construction. This model moves the Engineer (Designer) position in other models from being a direct, contractual advocate of the Owner to some contractual relationship with the builder. The Design-Builder is responsible for taking a concept developed by the Owner, completing the detailed design, and the pending the Owner's approval on the design, they can proceed with construction. A DB contract fundamentally differs from a DBB contract in the manner in which risk and responsibility for design details are shifted from the Owner to the Design-Builder.

There are two main advantages to using a Design-Build contract model. First, the construction team is motivated to work with the design team to develop a design with constructability in mind. It is, therefore, possible for the team to creatively find ways to reduce construction costs without reducing the functional aspect of the final product. The Owner can expect a reduced price due to the increased constructability of the design. The other major advantage involves the schedule. Many projects face an extremely tight schedule. By using the DB model, the contractor is established, and early mobilization and construction activities are able to proceed concurrently with the design. Under a traditional contract, construction can't begin until after the design is finished, the project is then bid and awarded, and the project team can mobilize. It is found that projects using this type of contract model can take months off the finish date of a project.

It is noted that no discussion has been made in this manual pertaining to the appropriateness and/or adaptability of the contract management methods presented to regional/local situations due to the fact that selecting and using an appropriate contract management model takes more than just a set of procedures and guidelines. It requires the integration of these standards into the culture of an organization which requires change in the corporate culture and not necessarily in terms of regional/local situations and cultural changes are always painful. In addition, the project management maturity of an organization has a tremendous effect upon the way that contract management is carried out within the project environment.

Fig. 10 illustrated a DB organizational model versus a DBB one.

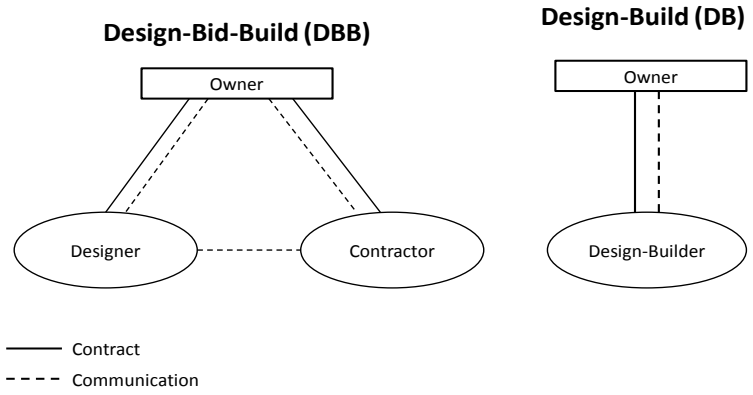


Fig. 10 Contractual Relationships for Design-Bid-Build and Design-Build

6.3.3 CONSTRUCTION MANAGEMENT (CM)

The CM model has become a generally accepted alternative to the traditional DBB contract model. Under a variety of conditions, this is the best way to meet an Owner's project objectives. It treats the project planning, design and construction phases as integrated tasks. The key concept of this model is it unites a three-party team consisting of the Owner, the Designer and the Contractor in a non-adversary relationship, and it provides the Owner with an opportunity to participate fully in the construction process. This team works together from the beginning of design to project completion, with the common objective of best serving the Owner's interests. Contractual relationships among members of the project team are intended to minimize adversary relationships and contribute to greater responsiveness within the project management group. Interactions relating to construction cost, environmental impact, quality, and completion schedule are carefully examined by the team so that a project of maximum value to the Owner is realized in the most economical time frame.

When an Owner chooses the CM model for the execution of his/her contract, he/she is involved in orchestrating the entire project and making decisions. An Owner begins a project by selecting his own three-party team. The Owner is in charge of his team as team members are hired under separate contracts and then brought together by the Owner right from the early stages of the project. The results of this early collaboration make all the difference to a project. This early collaboration between team members helps reduce an Owner's risk because the team draws on each other's area of specialization to maintain a tighter control over the details of a project that affect budget, schedule and quality.

A CM could well include a qualified general contractor, a qualified design-build firm or a qualified construction management firm.

Fig. 11 illustrates a typical CM model.

The CM contract model replaces the traditional DBB one with three contracts: Owner-Engineer (Designer), Owner-CM, and Owner-Contractor. The CM company becomes an additional party engaged in the project to act as an advisor to the Owner, to which they are contractually tied. The CM's role is to provide construction advice to the Engineer, on the Owner's behalf, design advice to the Contractor, again on the Owner's behalf, and other advice as necessary.

There are two general types of CM model: Agency Construction Manager (ACM) and Construction Manager-at-Risk (CM-at-Risk)

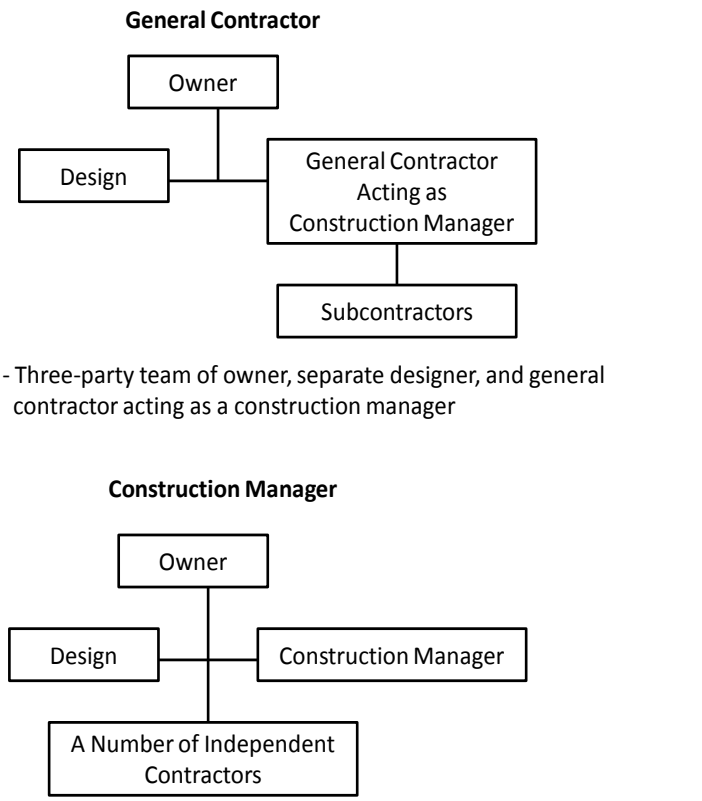


Fig. 11 Construction Management (CM) Model

6.3.3.1 Agency Construction Management (ACM)

A CM acting as an agent of the Owner and represents the Owner's interest at every stage of the project. An ACM functions wholly within the policies, procedures, and practices of the Owner's organization. The level of service by the ACM can range from on-call advice to full project management services. In some cases, the Owner hires the ACM before design begins. The ACM may participate in the selection of the design team as well as the construction team and manage the design preventing scope creep, helping the Owner stay within a pre-determine budget by performing value engineering, cost/benefit analysis, etc.

6.3.3.2 CM-at-Risk

CM-at-Risk is a delivery model which entails a commitment by the CM to deliver the project within a Guaranteed Maximum Price (GMP). The CM acts as a consultant to the Owner in the development and design phase (Pre-construction services), during which the CM-at-Risk and the Engineer (Designer), manage and undertake those functions, with variable participation by the Owner. During the construction phase, the CM acts as a general contractor in engaging the design, specialty, and trade sub-consultants and subcontractors necessary to complete construction. In addition to acting in the Owner's interest, the CM must manage and control construction costs not to exceed the GMP.

7. PROJECT INITIATION

7.1 THE PROJECT OPENING FORM (OR PROJECT CHARTER)

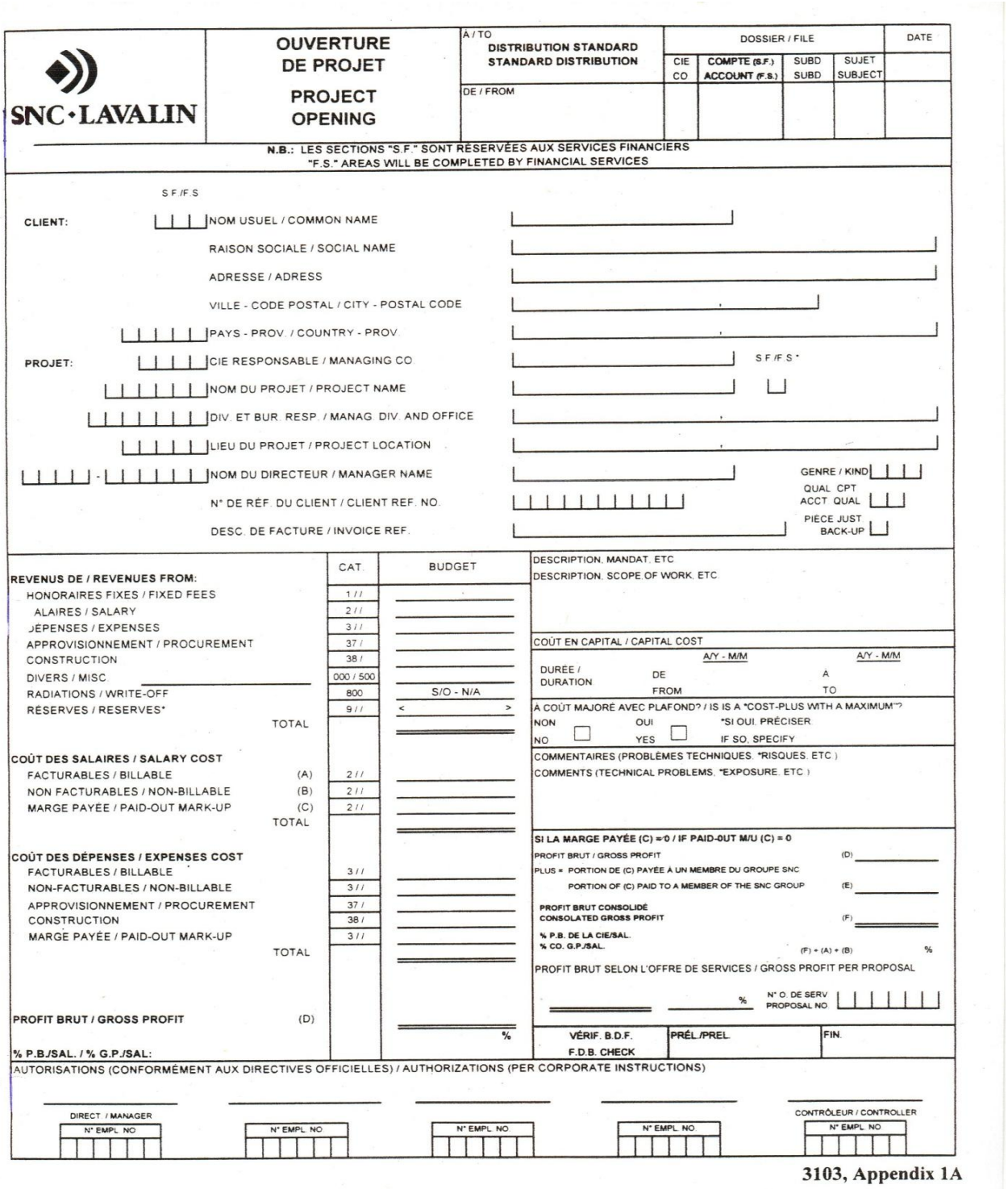
Project initiation formally defines and authorizes a new project with the objective of obtaining authorization to start the project. Within initiation, the initial scope is defined and initial financial resources are committed. Develop the Project Assignment Sheet (PAS); Project Opening form or Project Charter; is the process of developing a document that formally authorizes a project and records the official opening of a project. Project initiation includes the process of identifying stakeholders, all people or organizations impacted by the project, and documenting relevant information regarding their interests, involvement, and impact on project success. The PAS is prepared by the administrative assistant. The data contained in the PAS describes the new project, the scope of the services, the commercial terms and the project budget. The project manager is responsible for the completion of the PAS and for obtaining the required approvals. No contract number can be assigned to the new project before the completion and approval of this form. A purchase order, a letter of intent, or a contract signed by the Client and the responsible company authority must be available when the project manager obtains the necessary approvals and when he submits the form to the financial controller.

Through the PAS, he reviews available information and the contract, establishes objectives, policies, etc. for the project. He reviews these with the Chiefs of Disciplines, and the project key managers. He plans how he wants to accomplish in the planning phase.

In certain situations, when a project moves beyond initiation, a Project Manager is assigned and a project sponsor is appointed, making it possible for the project to move forward to planning. As part of the Initiating phase, the project manager is given the authority to apply organizational resources to the subsequent project activities.

Involving the Client and other stakeholders during initiation generally improves the probability of shared ownership, deliverables acceptance as well as client and other stakeholders' satisfaction.

Fig. 12 shows a typical SNC-LAVALIN project charter.



SNC·LAVALIN

OUVERTURE DE PROJET

PROJECT OPENING

À / TO: DISTRIBUTION STANDARD / STANDARD DISTRIBUTION

DE / FROM

DOSSIER / FILE: CIE CO | COMPTE (S.F.) ACCOUNT (F.S.) | SUBD SUBD | SUJET SUBJECT

DATE

N.B.: LES SECTIONS "S.F." SONT RÉSERVÉES AUX SERVICES FINANCIERS
"F.S." AREAS WILL BE COMPLETED BY FINANCIAL SERVICES

S.F./F.S.

CLIENT: NOM USUEL / COMMON NAME
RAISON SOCIALE / SOCIAL NAME
ADRESSE / ADRESS
VILLE - CODE POSTAL / CITY - POSTAL CODE
PAYS - PROV. / COUNTRY - PROV.

PROJET: CIE RESPONSABLE / MANAGING CO — S.F./F.S.*
NOM DU PROJET / PROJECT NAME
DIV. ET BUR. RESP. / MANAG. DIV. AND OFFICE
LIEU DU PROJET / PROJECT LOCATION
NOM DU DIRECTEUR / MANAGER NAME — GENRE / KIND
N° DE RÉF. DU CLIENT / CLIENT REF. NO. — QUAL. CPT ACCT. QUAL
DESC. DE FACTURE / INVOICE REF. — PIÈCE JUST. BACK-UP

REVENUS DE / REVENUES FROM:		CAT.	BUDGET
HONORAIRES FIXES / FIXED FEES		1 / /	
SALAIRES / SALARY		2 / /	
DÉPENSES / EXPENSES		3 / /	
APPROVISIONNEMENT / PROCUREMENT		37 /	
CONSTRUCTION		38 /	
DIVERS / MISC.		000 / 500	
RADIATIONS / WRITE-OFF		800	S/O - N/A
RÉSERVES / RESERVES*		9 / /	< >
	TOTAL		
COÛT DES SALAIRES / SALARY COST			
FACTURABLES / BILLABLE	(A)	2 / /	
NON FACTURABLES / NON-BILLABLE	(B)	2 / /	
MARGE PAYÉE / PAID-OUT MARK-UP	(C)	2 / /	
	TOTAL		
COÛT DES DÉPENSES / EXPENSES COST			
FACTURABLES / BILLABLE		3 / /	
NON-FACTURABLES / NON-BILLABLE		3 / /	
APPROVISIONNEMENT / PROCUREMENT		37 /	
CONSTRUCTION		38 /	
MARGE PAYÉE / PAID-OUT MARK-UP		3 / /	
	TOTAL		
PROFIT BRUT / GROSS PROFIT	(D)		
% P.B./SAL. / % G.P./SAL.:			%

DESCRIPTION, MANDAT, ETC
DESCRIPTION, SCOPE OF WORK, ETC.

COÛT EN CAPITAL / CAPITAL COST

DURÉE / DURATION — DE / FROM (A/Y - M/M) — À / TO (A/Y - M/M)

À COÛT MAJORÉ AVEC PLAFOND? / IS IS A *COST-PLUS WITH A MAXIMUM"?
NON / NO ☐ OUI / YES ☐ *SI OUI, PRÉCISER / IF SO, SPECIFY

COMMENTAIRES (PROBLÈMES TECHNIQUES, *RISQUES, ETC.)
COMMENTS (TECHNICAL PROBLEMS, *EXPOSURE, ETC.)

SI LA MARGE PAYÉE (C) = 0 / IF PAID-OUT M/U (C) = 0

PROFIT BRUT / GROSS PROFIT (D)
PLUS = PORTION DE (C) PAYÉE À UN MEMBRE DU GROUPE SNC
PORTION OF (C) PAID TO A MEMBER OF THE SNC GROUP (E)
PROFIT BRUT CONSOLIDÉ / CONSOLATED GROSS PROFIT (F)
% P.B. DE LA CIE/SAL. / % CO. G.P./SAL. (F) ÷ (A) + (B) %

PROFIT BRUT SELON L'OFFRE DE SERVICES / GROSS PROFIT PER PROPOSAL
% — N° O. DE SERV. / PROPOSAL NO.

VÉRIF. B.D.F. / F.D.B. CHECK | PRÉL./PREL. | FIN.

AUTORISATIONS (CONFORMÉMENT AUX DIRECTIVES OFFICIELLES) / AUTHORIZATIONS (PER CORPORATE INSTRUCTIONS)

DIRECT. / MANAGER — N° EMPL. NO. | N° EMPL. NO. | N° EMPL. NO. | N° EMPL. NO. | CONTRÔLEUR / CONTROLLER — N° EMPL. NO.

3103, Appendix 1A

Fig .12 Project Opening Form (Project Charter)

8. PROJECT PLANNING

This is the pivotal phase during which we establish in details, the EPCC objectives (Scope, Quality, Cost and Time). The objectives of project planning is mainly to lay the foundation for project execution as well as plan the course of actions to meet the project objectives and deliver the scope of the project, .i.e., put in place resources and schedule, the project plan, progress tracking tools, approval process and appropriate lines of communication. Project planning includes the following activities:

8.1 SCOPE MANAGEMENT

8.1.1 PRELIMINARY SCOPE DEFINITION

Scope of the Work: This is stated in the contract and should be in such a format that it can be used in the project plan.

Scope of the Services: This is stated in the contract documents and should also be in a format that can be used in the project plan. The scope of the services will eventually be elaborated in the detailed work and manpower control format.

Scope of the Commissioning: Describe the overall commissioning program required for successful start-up of facilities.

8.1.2 UPDATE PRELIMINARY SCOPE

The Preliminary Scope Definition developed earlier must now be updated with conclusions from Site and Local Investigations, Preliminary Design criteria and Preliminary engineering. Consequently, we can develop better descriptions of the scope of work, the scope of services, and the scope of commissioning.

8.1.3 PRELIMINARY WORK BREAKDOWN STRUCTURE (WBS) AND PACKAGES

The WBS is the basic planning structure and shows what the project consists of based on the Scope of Work. It provides a means for breaking down the project into subdivisions and components at successively lower levels in an orderly manner to establish a system for coding and reporting. It provides a total picture of the project content and establishes a basis for selecting project milestones and assigning project responsibilities. It helps to organize the work in a manner so as to reduce the chance of omission and provides a method of cost summarization. The sub-elements of the WBS can be summarized into work packages (construction contracts, purchase orders) and eventually, the WBS will allow you to identify all the subcontractors responsible for executing the work. The WBS can also be used as a check list for the network diagramming.

8.1.4 COMPLETE SCOPE DEFINITION

The Plant (Product): With the preliminary description as taken or modified from the contract and having done a part of preliminary engineering, a full plant description can be made,

with flow sheets and layouts, even with some preliminary design as well as engineering information for estimating.

The Services: With the preliminary description as taken or modified from the contract and having made a detailed but preliminary listing of item in the scope of services, a better idea of the services we have to do emerge. Each discipline in the project team should now go through the available project information, check against their own check list, and make a listing of all the things they have to do to meet the deliverables requirements.

This plan will define the extent of the contractor responsibilities and the tasks which will be directly performed by the Client.

8.1.5 FINALIZE THE WBS

The WBS, started earlier, can now be finalized. It is the basis for the coding of cost elements, and is therefore, the most important cornerstone in project management.

The WBS is finalized by establishing control accounts for the work and a unique identifier from a code of accounts. These identifiers provide a structure for hierarchical summation of costs, schedule, and resource information. A control account is a management control point where scope, cost and schedule are integrated and compared to the earned value for performance measurement. Control accounts are placed at selected management points in the WBS. Each control account may include one or more work packages, but each of the work packages must be associated with only one control account. Control account is a point representing the intersection of the WBS and the Organization Breakdown Structure (OBS) at which functional responsibility for work is assigned. Control accounts are the points for the integration of scope, cost and schedule and used in Earned Value Management (EVM) for integrated Cost/Schedule control approach.

Finalizing the WBS will also result in the WBS dictionary which is a document generated by the WBS process. It provides more detailed, narrative descriptions of the WBS components, including control accounts and work packages. The final WBS must be **clear**, **complete**, **correct** and **current** (4C's).

Figures 13 and 14 show the Work Breakdown Structure (WBS) concept and Figures 15 and 16 show the Establish of Control Account for Integrated Cost/Schedule Planning

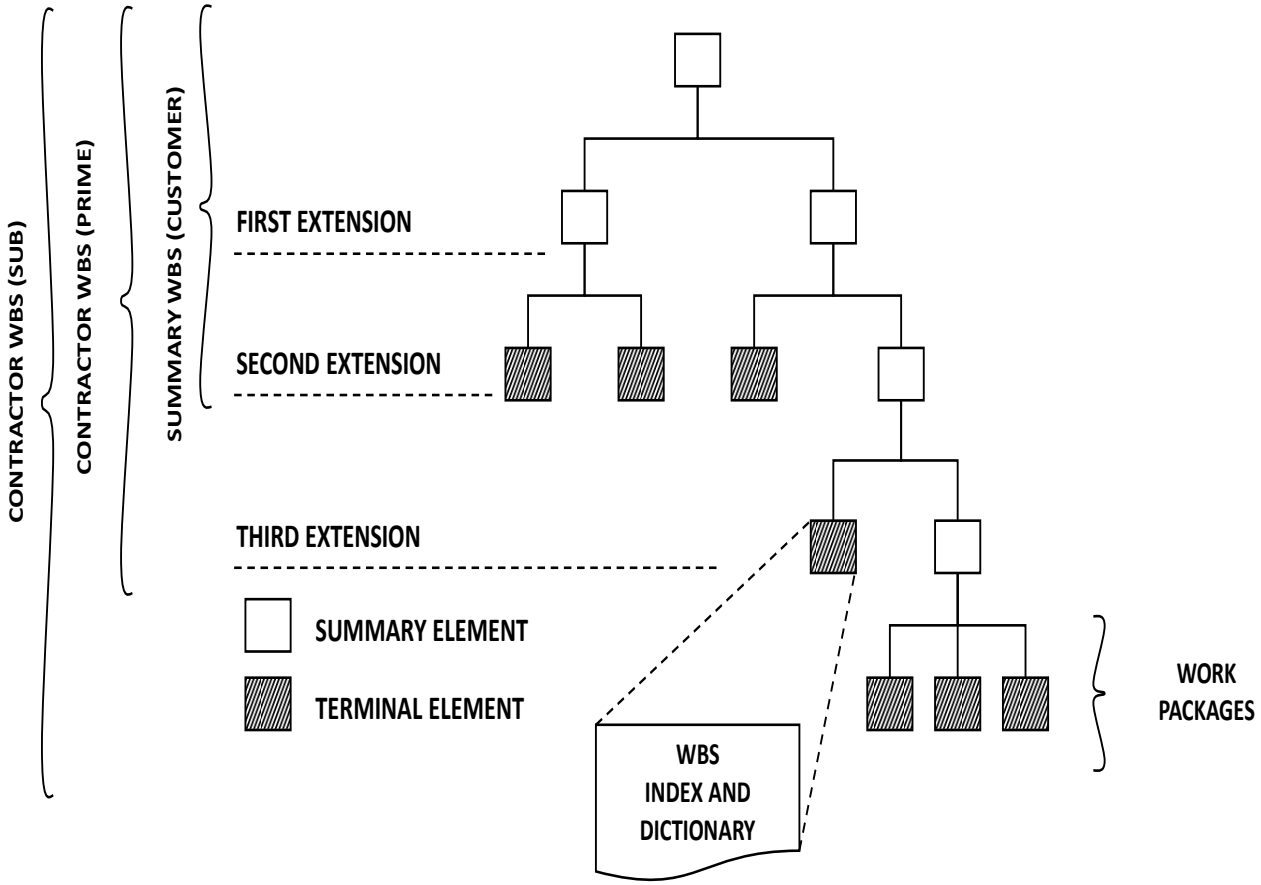


Fig. 13 The Work Breakdown Structure (WBS) Concept

1000 Permanent Support Facilities
2000 Reservoir, Diversion, Dam, Spillway
- **2100 Reservoir**
- **2200 Diversion**
- **2300 Dam**
- **2400 Spillway**
- **2500 North Spur Stabilization**

3000 Power Plan and Related Facilities
- **3100 Powerhouse, Intake, Tailrace Civil Works**
- **3200 Turbines and Generators**
- **3300 Electrical Ancillary Equipment**
- **3400 Mechanical Ancillary Equipment**
- **3500 Generator Transformers and HV Switchyard**
- **3600 Spareparts and Special Tools**

4000 Comminications

4100 Communications

5000 ConstructionFacillities and Suport

5100 Muskrat Site

5200 Happy Valley-Groose Bay

6000 Project Management, Engineering and Others

6100 Project Management and Engineering

6200 Field Investigations and Hydraulic Model Studies

6300 Contingencies

Fig. 14 The WBS Concept (in Tabular Format)

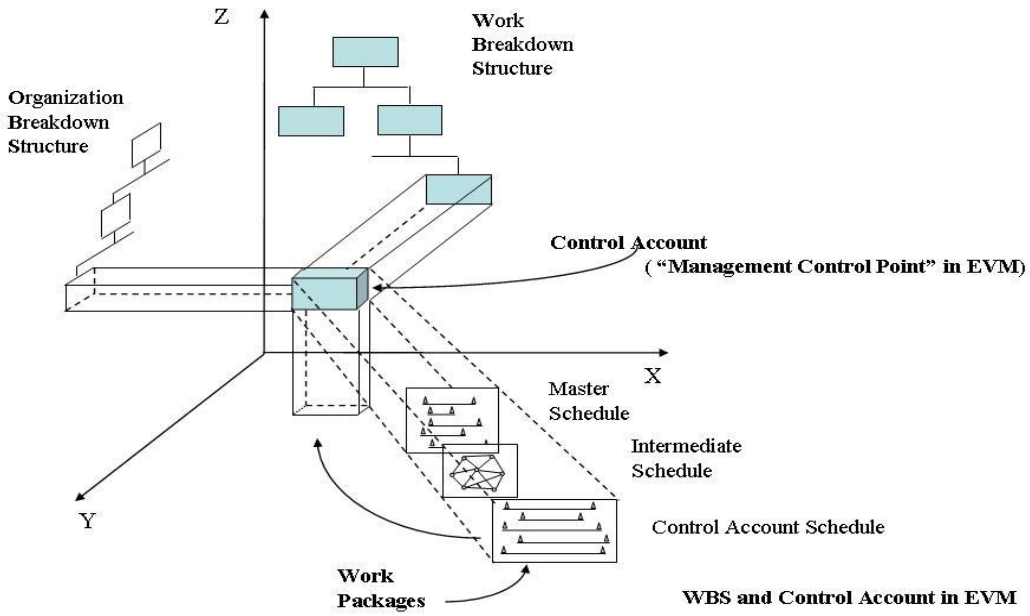


Fig. 15 Establish of Control Account for Integrated Cost/Schedule Planning

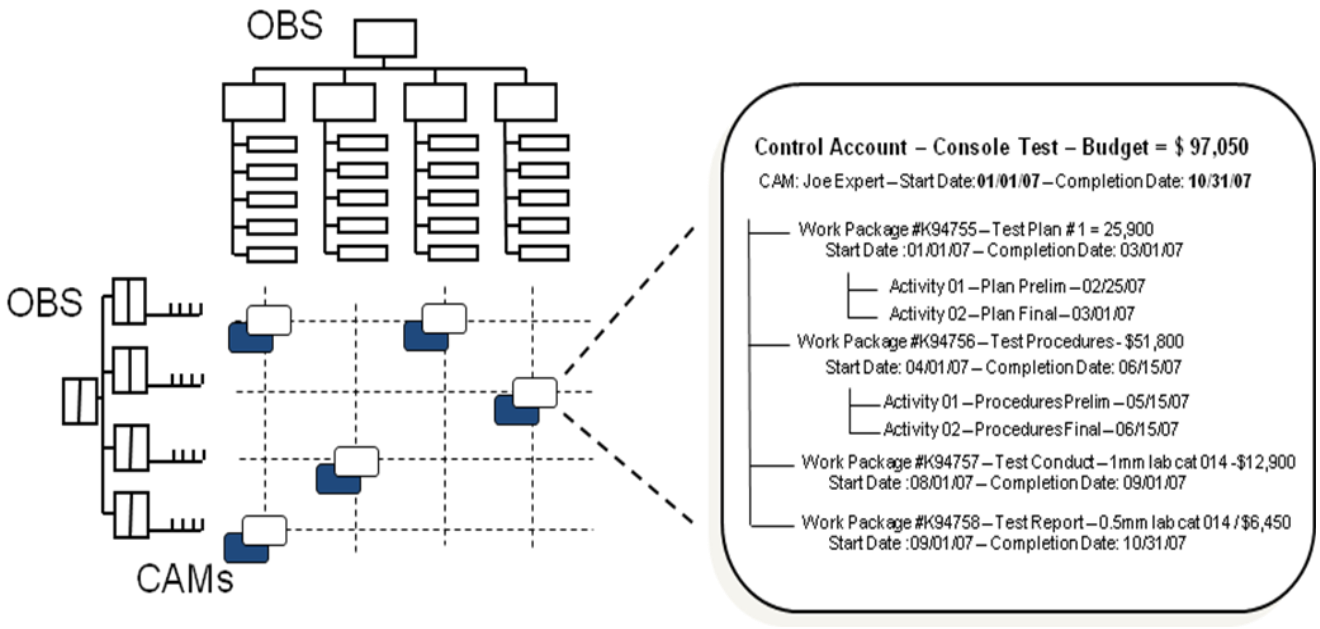


Fig. 16 Example of a Control Account (CA)

8.2 TIME MANAGEMENT

Time management includes the planning and scheduling processes required to manage timely completion of the project. Planning defines the scope, logic and sequence of the work to be executed and scheduling puts the plan on a calendar basis after durations and resources have been allocated to optimize cost and time. A complete schedule cycle covers statusing, monitoring, updating, forecasting and reporting. It involves the following activities:

8.2.1 PRELIMINARY MILESTONE LIST & MILESTONE SCHEDULE

Establish a Preliminary Milestones List by selecting a number of milestones, in consultation with the Client's Project Manager, to form the basis for communication at the total project level. A milestone is a key event selected as an important reference point in the accomplishment of a project. Progress of the work according to the plan is monitored primarily against these points in time. As a rule of thumb, it is useful to have on average about one milestone per month spaced at 1-2 months intervals. Milestone dates might include the completion of cost/benefit studies; completion of design and constructability reviews; completion of bid packages; completion of 90% of drawings, etc. A preliminary milestone schedule is prepared based on the WBS and the project's milestone dates. This will serve as the project master schedule until the detailed planning is complete and the baseline project schedule is issued.

8.2.2 PRELIMINARY MASTER NETWORK & SCHEDULE

Based on the WBS and the Preliminary Milestones Schedule, a master network and schedule is prepared once the procurement strategy and construction packaging have been defined.

This will outline the Project Manager's strategy as to how the project will be executed to meet the project milestone objectives. Once a master schedule is accepted by the Client, it is the responsibility of the project manager and his project team to monitor the progress of the activities on the master schedule and recommend or take appropriate actions when progress deviates from the established plan. When the network diagram is completed, the milestones and all relationships shown, activity durations can be entered and the preliminary schedule can be established. A good rule to follow for the preliminary network is to develop it to the third or fourth level of the WBS. Make sure to do the bulk of the planning for commissioning before the commencement of commissioning.

Fig. 17 shows a typical of Master Schedule Hierarchy "Roll-Up".

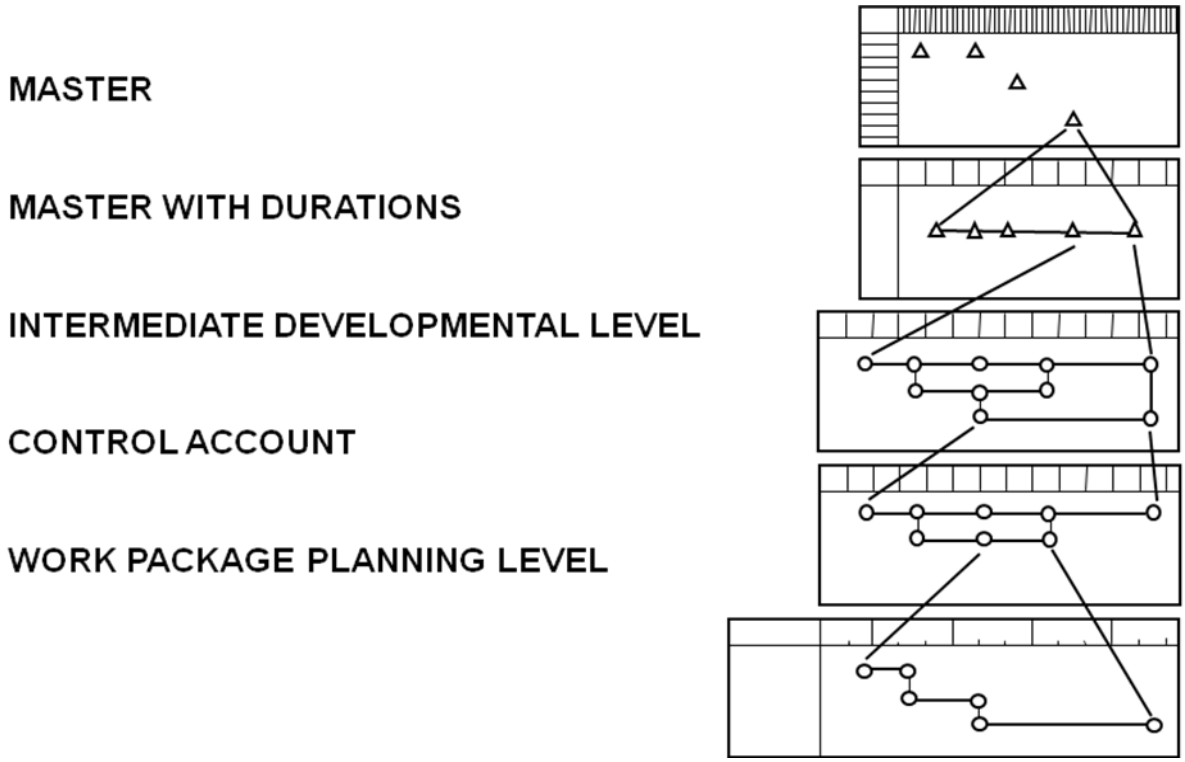


Fig. 17 Master Schedule Hierarchy "Roll-Ups"

8.2.3 ESTABLISH RESOURCES REQUIRED AND SOURCES

The purpose of this activity is to define all resources required (no quantifying of resources yet) and identify the available sources for the resources.

8.2.4 UPDATE WORK AND MANPOWER CONTROL

With the scope well established and a master network with a package schedule produced, the work and manpower control document can be finalized.

8.2.5 SITE MANPOWER AND LEVELLING

From the definitive estimate, we will have the amount and kind of site labour required to establish and level peak manpower and duration for each trade on site.

8.2.6 UPDATE NETWORK PLAN AND MAKE BAR CHARTS

Now that material and labour quantities are established, we can assess the manpower required and balance this with the manpower that can be made available. Using the preliminary schedule and the resource availability information, provided to the project team, a computer scheduling simulation using the expected schedule dates and the planned resources available will be produced. If the results produce negative float, the critical resources are then re-evaluated and the simulation repeated until satisfactory resource levelled schedules are obtained. This will help to finalize the durations on the network plan, and establish practical starting times.

8.2.7 DEVELOP THE PROJECT SCHEDULE

This is the process of analyzing activities sequences, durations, resource requirements, and schedule constraints to create the project schedule. Entering the activities, duration, and resources into the scheduling tool generates a schedule with planned dates for completing project activities. Schedule development requires the review and revision of duration estimates and resource estimate to create an approved project schedule that can serve as a baseline to track progress. This baseline project schedule remains fixed for the duration of the project unless there are significant scope changes to warrant a new baseline schedule.

Fig. 18 shows the Project Schedule Development.

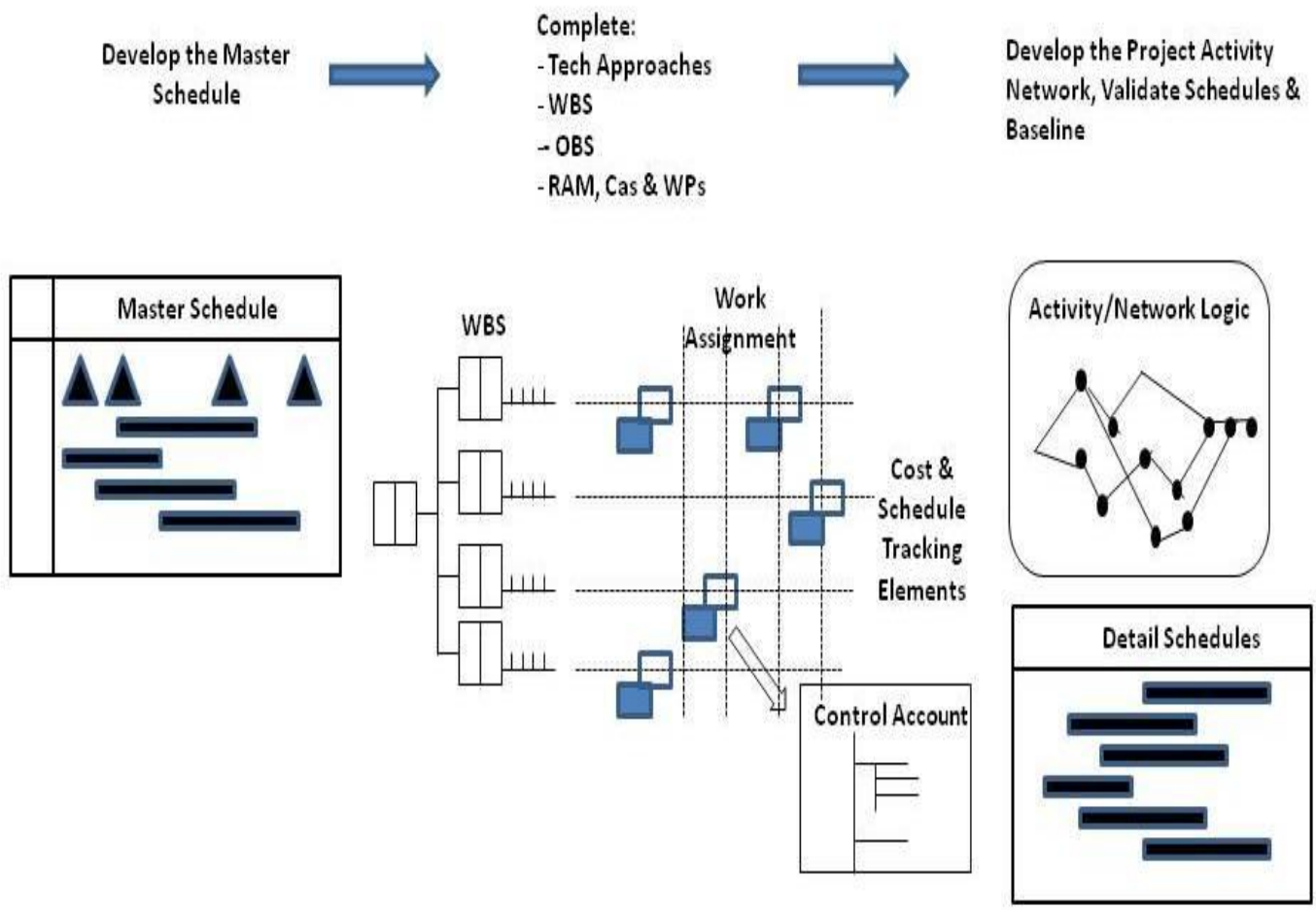


Fig.18 Project Schedule Development

8.3 COST MANAGEMENT

8.3.1 INITIAL SITE INVESTIGATION

- Use the company's site survey report for the site visit.
- Obtain at least sufficient information for preliminary planning.
- Establish schedule, budget, resources needed, logistics, communications and reports required.

8.3.2 INITIAL LOCAL INVESTIGATION

- Local labour availability.
- Local resources (sand, gravel, concrete).
- Local housing.
- Local suppliers.
- Local recreation
- Special requirements for overseas work.
- Transportation.

- Communication.
- Training facilities for Operating and Maintenance (O&M) personnel

This investigation is an extension of the site investigation.

8.3.3 PRELIMINARY CAPITAL COST ESTIMATE

This estimate provides a forecast of the cost of the proposed project and is used as a basis to establish a budget for the financing required and for the decision to proceed at all. The process design will have to be essentially completed, i.e., the processing sequence is established; the material and energy balances are done and that a preliminary specification for all pieces of equipment within the battery limits have been established.

The procedure to follow will be refined factoring techniques such as the equipment cost ratio or plant component cost ratio methods.

8.3.4 PRELIMINARY SERVICE COST ESTIMATE

Review the established scope of services. The cost of services for Project Management, Project Controls, Engineering, Procurement and Construction Management is a part of the capital cost estimate, and the cost of services for Commissioning is part of the Commissioning Cost Estimate.

Project Management and Project Controls services costs are ratioed from other service costs or from the capital cost and review for special circumstances

Engineering services cost is estimated by the number and kind of drawing and other information documents to be produced, multiplying this by hours per drawing and then converting this to clients' dollars.

Procurement services cost is estimated by the number of packages and by the number of people required during the schedule duration.

Construction management service cost has to consider whether the work is all sub-contracted by trade packages or whether it is done by our own force.

This approach is applied to both "cost plus" and "fixed cost" contracts. The ratio of this to the estimated construction costs is checked with applicable ratios from the company's historic records maintained by the estimating department.

8.3.5 PRELIMINARY COMMISSIONING ESTIMATE

Commissioning will be estimated at a separate budget package. It should include allowances for:

- Pre-commissioning inspection.
- Calibration and testing.
- Dry-runs and dynamic runs.

- Training of Operating and Maintenance personnel.
- Raw materials, chemicals, catalysts and utilities.
- Start-up maintenance and corrections during run-in.
- Performance testing.
- Staff, operators and maintenance personnel.
- Preparation of manuals and instructions.

8.3.6 FINALIZE PROJECT CODING

Now that we know all elements of the plant (the "what" we have to build), the services to be provided (the "what" we have to do), know how we are organized (the "who" is responsible), we can finalize our project coding. The project coding serves to identify primarily:

- Parts of the plant
- Services to be provided (by the Project Team, by Suppliers, by Contractors)
- The Coding is used to identify the elements of Scope/Quality, Cost, time, Resources, Documents and to identify responsibilities.

The final project coding becomes part of the Project Plan, it should have an overall illustration of all the coding elements and their typical usage.

8.3.7 UPDATE SERVICES COST BUDGET

Update the services budget for evaluation, review and approvals.

8.3.8 ESTABLISH DEFINITIVE ESTIMATE

This estimate is produced when preliminary engineering is substantially completed. This is the key estimate in the life of a project and constitutes the planning document for the "Cost" parameter by defining the scope and cost of the project. It establishes the "Target Cost" and is used as a yardstick for cost control purposes throughout the entire EPC implementation phase.

It can be prepared when the preliminary design is complete and the final design is advanced to about 20-30%:

- Design criteria
- Process Flow Sheets
- Equipment Lists
- Layouts, Sections
- Soil Data
- Foundation Features
- Structural Features

- Architectural Features
- Mechanical
- Piping
- Electrical Diagrams
- Instrumentation Diagrams

8.3.9 CASH FLOW PLAN

The cash flow plan is prepared with the knowledge of contract packages and purchase orders' timing, duration and cost. The project cost controller is responsible for the preparation of the cash flow plan.

Fig. 19 shows typical types of Cost Estimate.

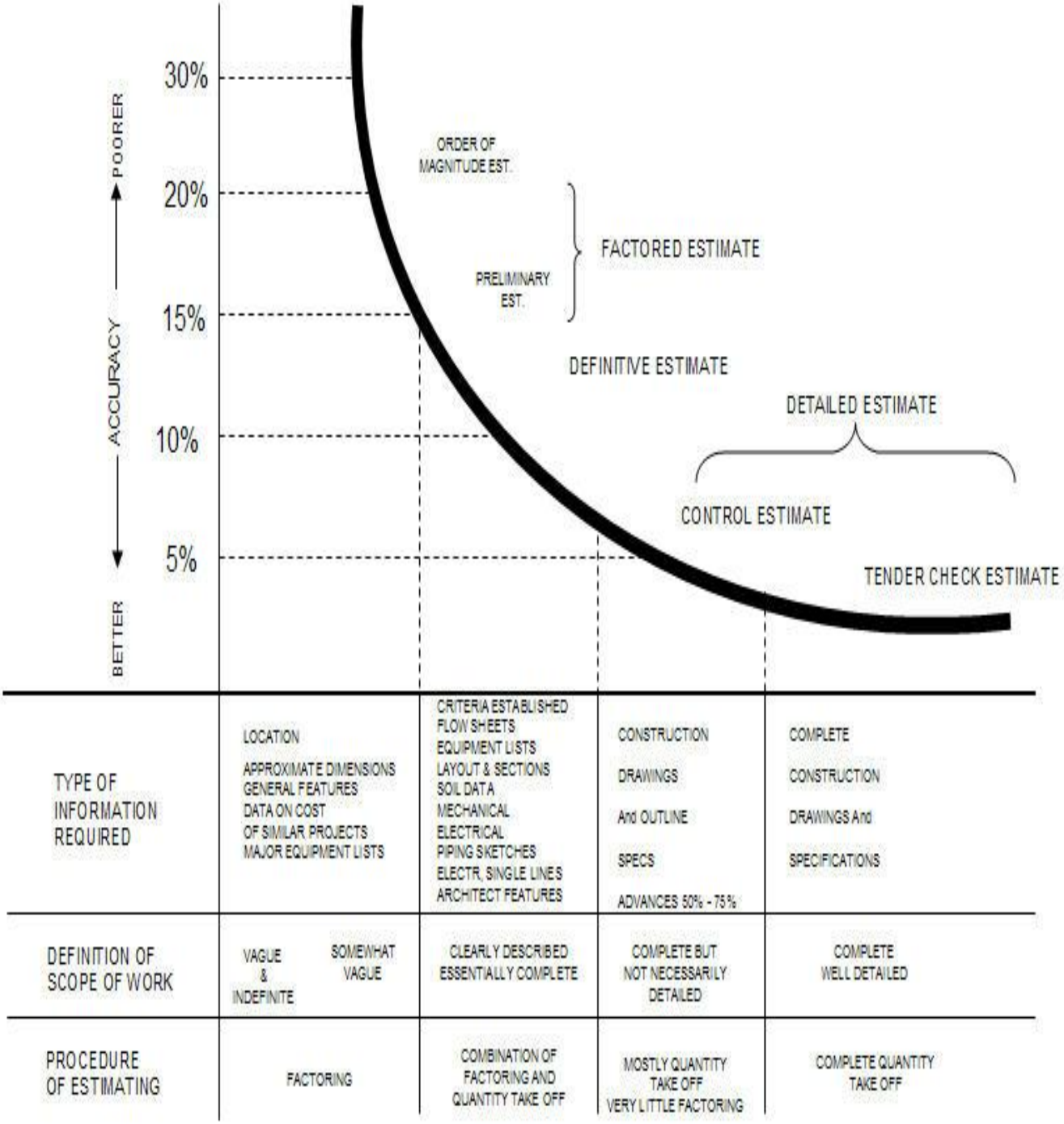


Fig. 19 Types of Cost Estimate

8.4 ENGINEERING MANAGEMENT

8.4.1 INITIAL (CONCEPTUAL) ENGINEERING

This is the engineering required to a point where the initial project breakdown structure can be prepared. This includes:

- Plot plan and building configuration.
- Preliminary process flow sheets.
- Preliminary design criteria.
- Initial site and local investigations.
- Standard equipment specifications.

8.4.2 PRELIMINARY DESIGN CRITERIA

The purpose of the preliminary design criteria is to provide the basis for the preliminary engineering activity; whose objectives govern the scope of the preliminary design criteria. This scope has to be defined by the Project Engineering Manager.

8.4.3 PRELIMINARY ENGINEERING

The purpose of this part of Preliminary Engineering is:

- Add information for the updating of the preliminary scope and for the preliminary WBS.
- Provide additional information to allow estimating to make the preliminary cost estimate.

Estimating and Engineering have to work out together the content listing and definition of this type of preliminary information which include:

- Preliminary design criteria
- Final flow sheets
- Preliminary equipment lists
- Preliminary layouts, sections
- Preliminary soil data
- Preliminary foundation & structure features
- Preliminary mechanical concept
- Preliminary piping
- Preliminary electrical concept
- Preliminary single line diagram
- Preliminary automation concept

8.4.4 COMPLETE PRELIMINARY DESIGN

This is the final updating of the Preliminary Engineering in the Preliminary Project planning. It is to incorporate changes, all to such a degree as to allow for the finalization of the WBS

and with approximate 30% of final design allowing for the preparation of the definitive estimate. Estimating and Engineering have to work out together the content listing and definition of the complete preliminary design and the 30% of the final design.

8.4.5 FINALIZE CONTRACT PACKAGE

Contract packages are defined as technical and commercial documents, which eventually end up in a purchase order or a construction contract. The purpose of work packages is to achieve functional planning and control for engineering, procurement, construction, commissioning, management in manageable packages.

8.4.6 ESTABLISH PROJECT CONTROL SYSTEM

Plan the project control systems that are going to be used on the project. Typical control systems that will have to be implemented are:

- Monthly Progress report.
- Integrated Coding System.
- Project Filing & Retrieval System.
- Document Control & Distribution System.
- Types of Reports & Frequency.
- Types of Control Charts, Frequency of Update and Distribution.
- Project Change Control.
- Work & Manpower Control.
- Procurement Data Control.
- CPM (Critical Path Method) Monitoring updates and reports.
- Services Cost Reports.
- Capital Cost Reports.
- Commissioning Cost Reports.
- Construction Worksheets.
- Labour Productivity Control.

Additional control plans that may be valuable:

- Quality Assurance plan.
- Safety plan.
- Standards plan.
- Inspection plan.

Depending on the number of specialists involved on the Client's side, it is useful to work with them so that they are aware of the essential features of our control systems that concern them. Whichever systems we are using, we must list them in the Project

Instructions. We also list in which way we deviate on the project from the "Standard Systems"

8.5 PROJECT ADMINISTRATION

8.5.1 INITIAL PROJECT PLAN

The initial project plan will be issued at the onset of the project even if incomplete. They will be completed as information becomes available and revised as required during the course of the project.

The purpose of the Project Plan is to acquaint all parties concerned with the scope, the people involved and where they can be reached, to establish the procedures to be followed and to outline the control methods to be used. The Project Plan is for the use by the whole project team. It is a live document and should make updating easier.

This document, therefore, provides information and specifies the quality objectives of the project. Depending on the size of the project, the project plan document can contain the summary of most of the standard procedures adapted to the needs of the project, or may only make reference to them. All project quality audits are carried out by using this document as the reference criterion. Each audit item of the pre-established quality audit evaluation check list refers to an article or a group of articles of the project plan.

8.5.2 INITIAL ORGANIZATION CHART

Only key project team members could be identified. It is good practice to get the construction project manager on board as early as possible. Functional departments supply the initial staff required as well as the methodology used and assist in the monitoring of their disciplines. Functional chiefs participate in the formal, planned reviews such as project panel reviews and panel design reviews. Only as the project progresses and the people are identified will we be able to update the complete chart.

8.5.3 PRELIMINARY PROJECT CHANGE NOTICE PROCEDURE

After the approval of the preliminary capital cost estimate, this procedure must be initiated. The purpose of such a procedure is to establish a control for changes in the agreed scope, budget and schedule for the project prior to the approval of the Definitive Estimate (Target Estimate). Ideally, all accumulated changes should be equal to the difference between the Preliminary Capital Cost Estimate and the Definitive Capital Cost Estimate.

8.5.4 ASSEMBLE DATA FOR PROJECT PANEL REVIEW MEETING

Prepare for the Project Panel Review at the end of the Preliminary Project Planning phase. Also, establish if, when and how a similar review should take place with the Client.

8.5.5 PROJECT PANEL REVIEW

The real positive result of the Project Panel Review is that the Project Manager and his team are tuned in with the company's management, i.e., they have the company behind them.

Prior to proceeding with the detailed planning to establish the Project Plan, the input, involvement, and commitment of the company's management, the Client must be evaluated in terms of its impact on the Project Plan.

8.5.6 COMPLETE THE PROJECT PLAN

In general, the Project Plan structure should be as follows:

1.0 General

- Title page
- Distribution
- Issue register
- Table of contents
- Introduction
- Type of contract
- Project summary
- Project objectives
- Project policies
- Miscellaneous

2.0 Scope of Work

- Scope of project
- Scope of services
- Project overall schedule (Milestones)
- Project site plan

3.0 Organization

- Client organization
- Project organization
- Job descriptions
- Chief of Disciplines

4.0 Project Administration Procedures

- Official instructions
- Project filing system
- Communication
- Document control
- Other administrative subjects
- Standard distribution

5.0 Project Controls procedures
6.0 Project Engineering procedures
7.0 Project Procurement procedures
8.0 Project Construction procedures
9.0 Project Commissioning procedures
10.0 Quality Assurance

8.6 RISK MANAGEMENT

Risk management includes the process of conducting risk management identification, assessment, response planning and monitoring and control of a project[6] (1). It is a management technique that identifies a concern (risk) that threatens the success of a project, focuses the project management attention on the concern, takes action to avoid the concern, and implements plans to neutralize or minimize the impact of such a concern should it materialize and increase the probability of a project's success[7] (3). It should also include a plan to maximize the results of positive events associated with the beneficial risk. The objective of risk management for construction projects is to provide a process for the early identification of risks and opportunities in order to allow them to be tracked and managed throughout the project. A structured risk management methodology should be one of the key project management processes and received the same level of attention as budget control and scheduling. It is expected to be a continuous process on projects and be integrated into the project management processes.

8.6.1 PRELIMINARY RISK MANAGEMENT

Preliminary identification of risk issues, assessment and prioritization of identified risks for performing risk analysis and establishment of preliminary risk response plan.

8.6.1.1 Risk Identification:

The process of examining the various project areas and each critical process to identify and document any associated potential risks. Risk identification meetings will include the company's Subject Matter Experts (SMEs), and if appropriate, subcontractors, suppliers or any other person or organization involved in the project. To identify project risk issues, all project leaders will be requested to provide individual lists of risk subjects relating to their areas of responsibility. They, then, will review their lists to ensure that each risk subject is actually a threat to the project's success and is within the control of the project team to influence. This process is implemented using the Work Breakdown Structure (WBS) as a framework of subjects to identify specific risk issues. The Project Manager or Risk Manager (for large projects) will interview each project leader to identify potential problems for each WBS elements. A composite list of risk subjects will be compiled for risk assessment.

Fig. 20 shows the Project Risk Identification process.

[6] See References 1 on last page.
[7] See References 3 on last page.

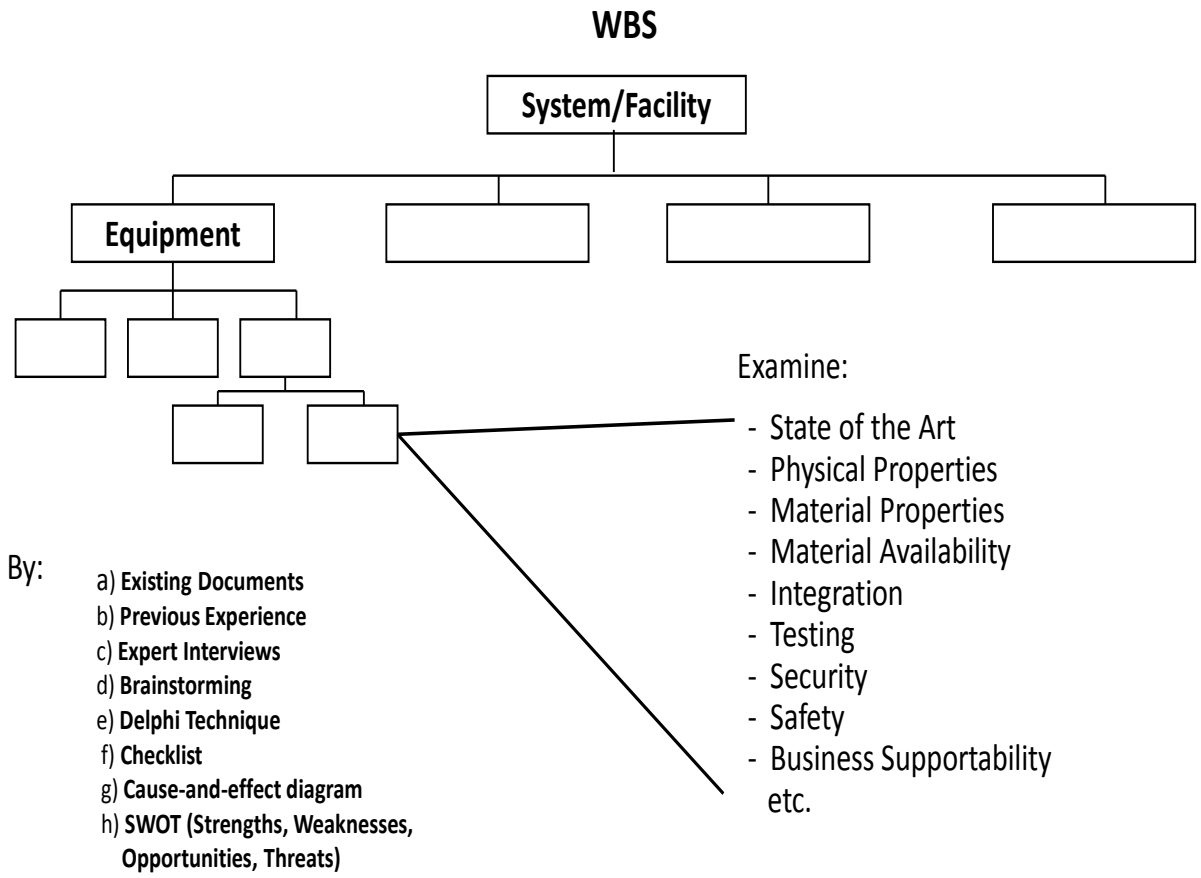


Fig. 20 PROJECT RISK IDENTIFICATION

8.6.2 RISK ASSESSMENT:

The process to identify the probability and impact parameters for each risk issue. The probability parameter indicates the degree of likelihood that the risk will materialize and can be expressed in quantitative or relative terms. Impacts are expressed in terms of cost and/or schedule and/or technical performance effects. A risk matrix is used to create an overall ranking for the project.

Fig. 21 shows the Risk Matrix for Risk Assessment purposes.

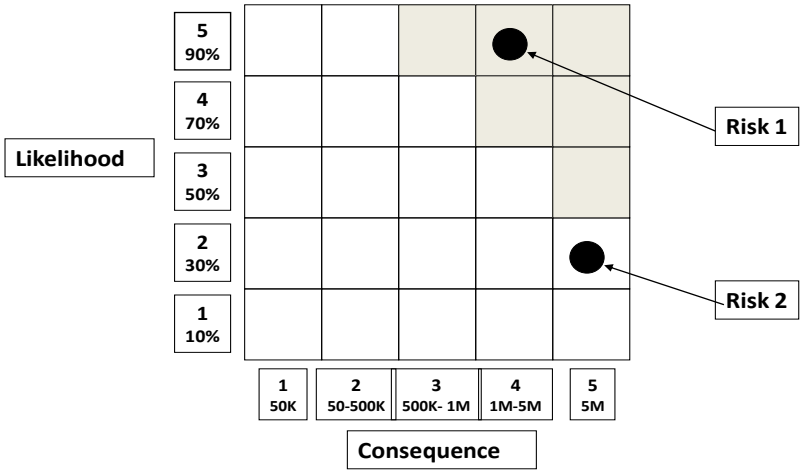


Fig. 21 Risk Matrix

8.6.3 COMPLETE RISK MANAGEMENT

Finalization of risk management plan with risk filtering, risk analysis and prioritization and risk responses for identified risks, risk tracking and reporting approach, risk management organizational responsibilities, risk database and reporting process. Development of options and actions to enhance opportunities and to reduce threats to project objectives.

8.6.3.1 Risk Filtering:

Early filtering of risk issues is key to effective risk management plan. All initial risk issues' basic data will be assembled and risks that are obviously the greatest threats to the project will be selected for risk management purposes. The filtering process will lead to the selection of risk issues for risk management purposes, i.e., the process of identifying an appropriate set of key project risks that are threats to the project's success, controllable by the project team and, together, are a risk set that can be manageable considering project resources. This will result in the list of actual risks to be managed by the project's risk management process. This list will be modified as the project progresses since new risks may surface and some risks will disappear. Guidelines for the number of risk issues a project manager will manage are difficult to establish. The project team will have to make a common sense evaluation of all risks on the initial risk list and select a set of risks appropriate to manage.

Fig. 22 shows the Risk Filtering process.

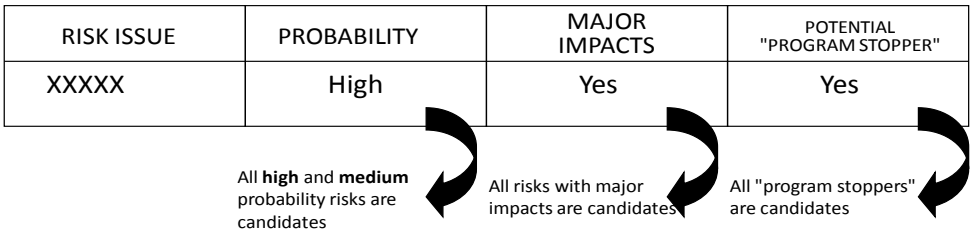


Fig. 22 Risk Issue Filtering

8.6.3.2 Risk Analysis and Prioritization:

The purpose of risk analysis is to understand the magnitude of the consequence should a risk materialize in order to develop strategies and tactics to mitigate the risk and thereby provide sufficient information so that decisions can be made on treatment priorities and planned resource allocation. Risk analysis is the process of examining each identified risk to refine the description of the risk, isolate the cause, and determine the effects and consequences (or benefits) should the risk materialize. It involves Qualitative Risk Analysis and Quantitative Risk Analysis.

In qualitative risk analysis, risks are analyzed based on the relative probability or likelihood of occurrence, the corresponding impact on project objectives if the risk occur, and other factors such as the time frame for response and the organization's risk tolerance associated with the project constraints of cost, schedule, scope, and quality. Performing qualitative risk analysis is usually a rapid and cost effective means of establishing priorities for planning risk responses and lays the foundation for performing quantitative risk analysis.

In quantitative risk analysis, the effects of identified risks on overall project objectives are numerically analyzed. Quantitative risk analysis is performed on risks that have been prioritized by the qualitative risk analysis process as potentially and substantially impacting the project's competing demands. It also presents a quantitative approach to making decisions in the presence of uncertainty.

Availability of time and budget, and the need for qualitative or quantitative statements about risk and impacts, will be a decisive factor in determining which method(s) to use on any particular project.

8.6.3.3 Risk Mitigation:

Risk Mitigation is the process of identifying, evaluating and selecting appropriate mitigation strategies and actions to eliminate or lower the probable consequence of a threat to an acceptable level given project constraints and objectives or maximize the benefits of an opportunity. This includes risk avoidance and risk contingency approaches.

Risk Avoidance Approach: is a process necessary to reduce the probability of occurrence for each risk selected for risk management. Each functional area defines what actions should be taken to avoid or reduce the probability of occurrence of every risk selected for risk management. The cost effectiveness of prospective risk avoidance approaches must be considered.

Risk Contingency Approach: is a process of defining what must be done to minimize the effects of a risk that has materialized as a project problem. Each functional area leader defines what contingency actions should be taken for each risk within their respective area of responsibility. These results in a contingency plan for each risk selected for risk management and a definition of what conditions must exist to initiate and end this risk contingency plan.

Fig. 23 shows a typical Project Risk Summary.

PROJECT RISK SUMMARY:							RISK #		
Division/Group	Manager:		Last Updated:				Rev.		
DESCRIPTION									
Probable Impacts	TOTAL	07/08	08/09	09/10	10/01	11/12	12/13	13/14	14/55
COST ($ x 1000)	TBD								
SCHEDULE									
PERFORMANCE									
SAFETY									

ABATEMENT/MITIGATION PLANS			CLOSURE CRITERIA
ACTION	ACTIONEE	DATE	
			Closure Authorized by: .... Risk Item Manager Date .... Project Manager Date

Fig. 23 Project Risk Summary

8.6.3.4 Other Risk Responses:

Risk Acceptance: An acknowledgement of the existence of a particular risk and a conscious decision to accept it without engaging in any further special effort to mitigate it, e.g., accepting a lower profit if some activities run over budget.

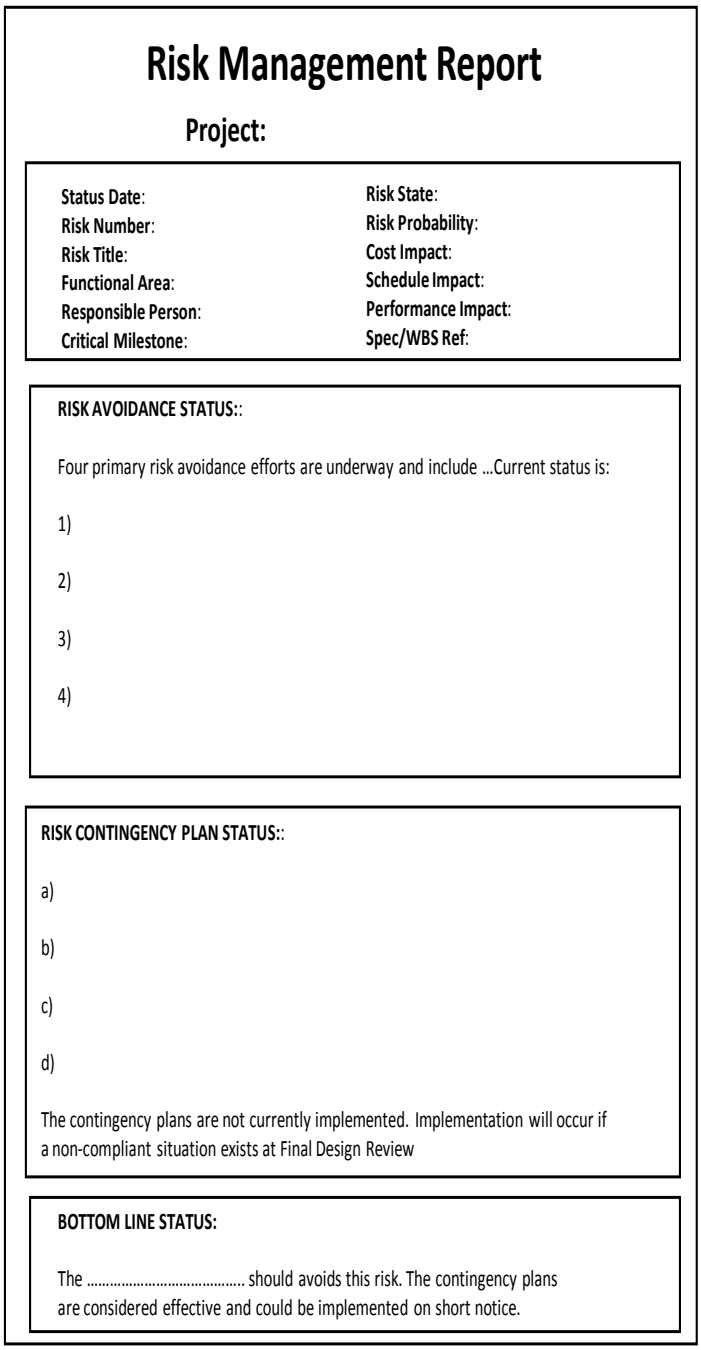
Risk Retirement: Occurs after all reasonable efforts have been made to mitigate the risk and it is no longer considered a threat to the project.

Risk Transfer: Involves ensuring that a risk resides within the project where it may be most effectively managed, e.g., buying an insurance policy for equipment.

8.6.3.5 Risk Tracking and Reporting Approach Definition

This is a process in which the status of risk issue must be monitored to decide if the identified risk avoidance approaches remain appropriate for existing risks and if risk contingency plans are being effective for risks that have materialized. The approach in which this monitoring effort is to be accomplished and risk status collected, reported and reviewed is defined by this process. Significant risks are to be reported in the risk problem analysis report. All functional managers define how each of their respective issues will be tracked. The project manager (or risk manager) will define how all of the risk status reports will be assembled, disseminated and addressed during the project panel review meetings. Risk management tracking partially will be accomplished via a risk management database containing pertinent data for each risk issue. A segment of this data base will be periodically updated as risk reports are provided.

Fig. 24 shows a typical Risk Management Report.



Risk Management Report

Project:

Status Date:
Risk Number:
Risk Title:
Functional Area:
Responsible Person:
Critical Milestone:

Risk State:
Risk Probability:
Cost Impact:
Schedule Impact:
Performance Impact:
Spec/WBS Ref:

RISK AVOIDANCE STATUS::

Four primary risk avoidance efforts are underway and include …Current status is:

1)

2)

3)

4)

RISK CONTINGENCY PLAN STATUS::

a)

b)

c)

d)

The contingency plans are not currently implemented. Implementation will occur if a non-compliant situation exists at Final Design Review

BOTTOM LINE STATUS:

The …… should avoids this risk. The contingency plans are considered effective and could be implemented on short notice.

Fig. 24 Risk Management Report

8.6.3.6 Risk Management Organization and Responsibilities Definition

This is the process of defining the risk management organization and its associated assigning responsibilities. It is the responsibility of the project manager to define the risk management organization and the associated responsibilities for each individual concerned.

Fig. 25 summarizes the Risk Management Planning process.

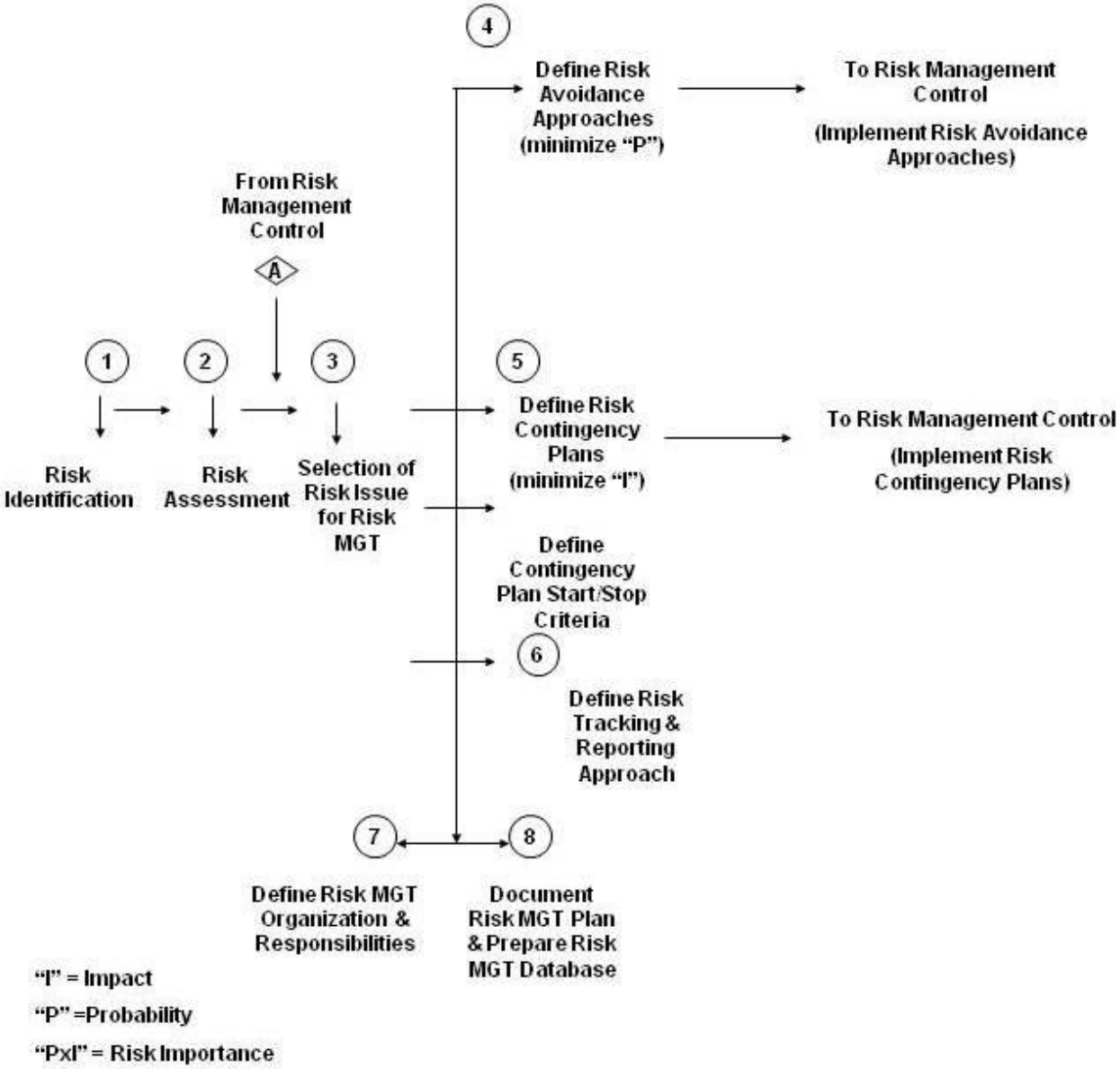


Fig. 25 Risk Management Planning

8.7 COMMUNICATION MANAGEMENT

This is the process of determining the project stakeholder information needs and defining a communication approach for the project. It responds to the information and communications needs of the stakeholders, e.g., who needs what information, when they will need it, how it will be given to them, and by whom. It also defines the communication format and frequency. The communication plan includes reports, meeting schedules, change processes, and contact information for the team. It lets the team members know the communication rules and the project expectations. Hence, identifying the information needs of the stakeholders and determining a suitable means of meeting those needs are important factors for project success. A good communication plan will allow the project manager to document the approach to communicate most efficiently with stakeholders.

8.7.1 STAKEHOLDER IDENTIFICATION

This is the process of identifying all people or organization impacted by the project, and documenting relevant information regarding their interests, involvement, and impact on project success. Project stakeholders are persons and organizations such as Clients, sponsors, suppliers, contractors, performing organizations, and the public that are actively involved in the project[8] (1). It is critical for project success to identify stakeholders early in the project, and to analyze their levels of interest, expectations, importance and influence. Typical characteristics that can make someone or an organization a stakeholder include whether to gain or lose through the success or failure of the project; provide funding for the project; invest resources in the project; participate in or work on the project; be affected by the outputs of the project, be affected by the outcome of the project, etc. A strategy can then be developed for approaching each stakeholder and determining the level and timing of stakeholders' involvement to maximize positive influences and mitigate potential negative impacts. The assessment and corresponding strategy should be periodically reviewed during project execution to adjust for potential changes.

Fig. 26 shows the Relationships between the Stakeholders and the Project.

[8] See References 1 on last page.

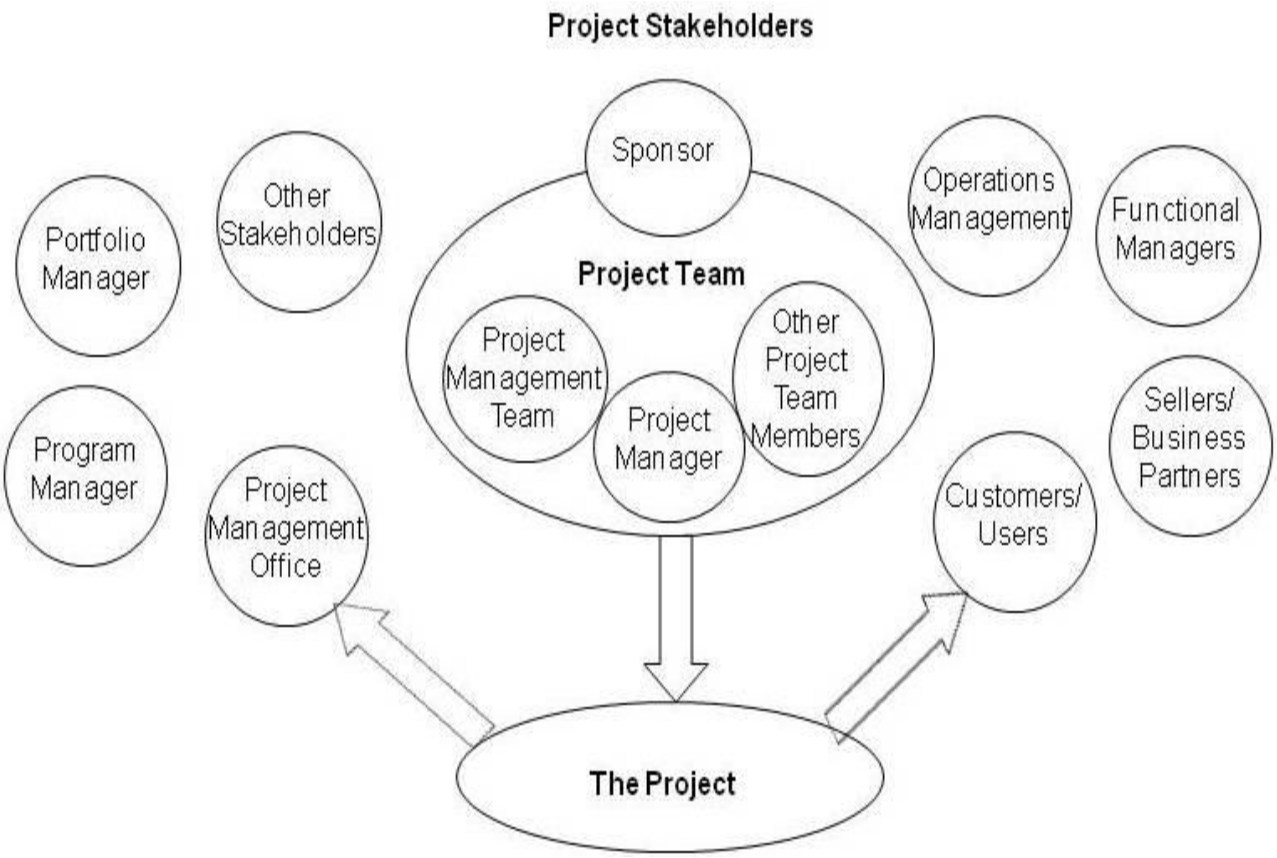


Fig. 26 The Relationship Between Stakeholders and the Project

8.7.2 STAKEHOLDER ANALYSIS

The analysis involves establishing a solid relationship between the project manager and the Client. This includes the following actions:

- Establish a solid relationship between the project manager and the customer, i.e., how do you want to work with the customer?
- Create a project culture with the stakeholders by understanding all their aspects of economic, demographic, educational, ethical, ethnic and religious characteristics.
- Maintain open communication channel.
- Set the stage for how communication will be planned.
- Practice effective risk management.
- Understand customer's perception in terms of diverse expectations, false assumptions, and possible ineffective communication.
- Be familiar with international, political and physical environment.

8.7.3 ESTABLISH COMMUNICATION PLAN

The communication plan is a subsidiary of the project plan. It usually includes key information as follows:

- Stakeholder communication requirements.
- Information to be communicated, including language, format, content, and level of detail.
- Reason for the distribution of that information.
- Time frame and frequency for the distribution of required information.
- Person responsible for authorizing release of confidential information.
- Person or groups who will receive the information.
- Methods or technologies used to convey the information, e.g., memos. E-mail, etc.
- Method of updating and refining the communications management plan as the project progresses and develops.
- Communication constraints, usually derived from specific regulation or legislation, technology and organizational policies, etc.

The communications management plan also includes guidelines and templates for project status meetings, project team meetings, e-meetings, and e-mails. The use of a project management website and project management software can also be included if they are used in the project.

8.8 QUALITY MANAGEMENT

This includes processes and activities of the performing organization that determine quality policies, objectives and responsibilities so that the project will satisfy the needs for which it was undertaken. It implements the quality management system through policy and procedures with continuous process improvement activities conducted throughout, as appropriated[9] (1). The objective of quality management is to monitor the supplier (contractor) compliance with the quality level expected for the project. The supplier is responsible for the quality control function and compliance with the quality required by the contract documents.

8.8.1 QUALITY REQUIREMENTS

Conformance to established requirements reflecting Clients' needs and expectations, to flag unrealistic, unnecessary or inappropriate requirements in order to concentrate our effort on meeting actual Client's requirements on a project. This is the process of identifying quality requirements and/or standards for the project and documenting how the project will demonstrate compliance.

[9] See References 1 on last page.

8.8.2 ESTABLISH QUALITY PLAN

This plan describes how the project management team will implement the performing organization's quality policy. It is a subsidiary plan of the project plan. The quality management plan provides input to the overall project plan and includes quality control, quality assurance, and continuous process improvement approaches for the project. The style and detail of the plan is determined by the project requirements. The quality management plan should be reviewed early in the project to ensure that decisions are based on accurate information. The quality plan should identify the various steps in design development leading to approval by the Client and other project stakeholders, e.g., government agencies, having jurisdiction over the project. The quality plan should be reviewed by all parties and modified as required and then agreed to in a formal sign-off procedure. A modification procedure should be developed for subsequent revisions to maintain a current and effective plan.

9. PROJECT EXECUTION

Project execution involves activities performed to complete the work cope defined in the project plan to meet the deliverables requirement. Execution includes coordinating people and resources and integrating and performing the project activities in accordance with the plan.

During project execution, results may require updating the planning which could include changes to expected activity durations, changes in resource productivity and availability, and unanticipated risks. Such variances affect the project plan and may require detailed analysis and development of appropriate project management responses. The results of the analysis can trigger change requests that, if approved, may modify the project and require establishing new baselines. A large proportion of the project's budget will be expended in performing project execution activities. The main project deliverables are completed during this phase. The role of the project manager during this phase is to effectively coordinating the performing activities and ensuring follow-up on project action items. Key activities during project execution include:

9.1 CRITICAL PATH/TIME MANAGEMENT

Time management is a difficult, time-consuming and arduous management function. Project managers need a management tool that will enable them to manipulate large number of project activities and complicated sequential relationships in a simple and understandable fashion. The Critical Path Method (CPM) is just an expedient and constitutes the basis for the ensuing treatment of project time control.

CPM techniques are based on a graphical project network of activities. This network presents in diagrammatic form those job activities that must be carried out and their mutual

time dependencies. It serves as a basis for the calculation of work schedules and provides a mechanism for controlling project time as the work progresses.

Fig 27 shows the network calculation and the Critical Path.

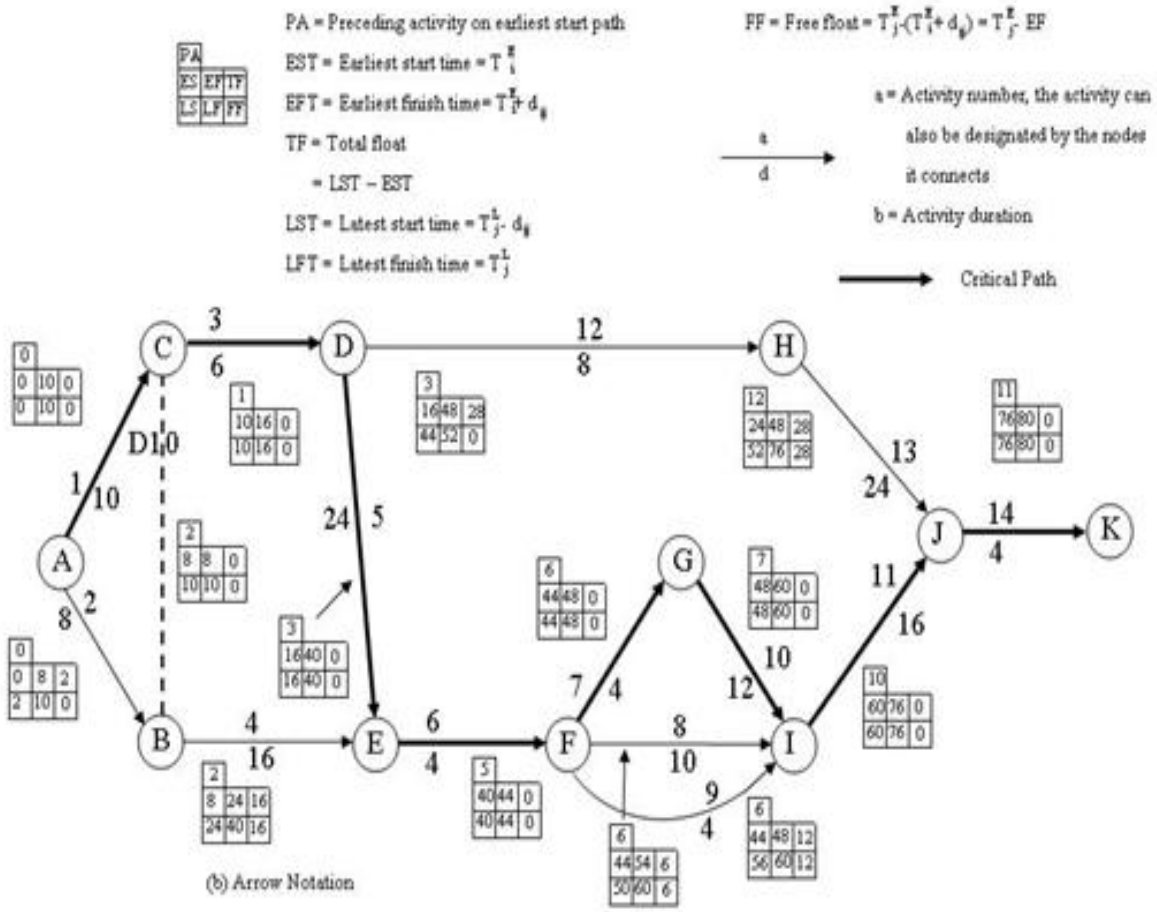


Fig. 27 Network Caculation: Critical Path

CPM is a three-phase procedure consisting of planning, scheduling, and time management. Planning construction operations involves the determination of what must be done, how it is to be performed, and the sequential order in which it will be carried out. Planning defines the scope, logic and sequence of the work to be executed. Scheduling determines calendar dates for the start and completion of project components. It puts the plan on a calendar basis after durations and resources have been allocated to optimize cost and time. Time management is the process of comparing actual job progress with the project baselined schedule. It includes schedule updates, schedule revisions, master schedule maintenance and schedule reports.

Fig. 28 presents the seven steps necessary to develop an effective time management for a project:

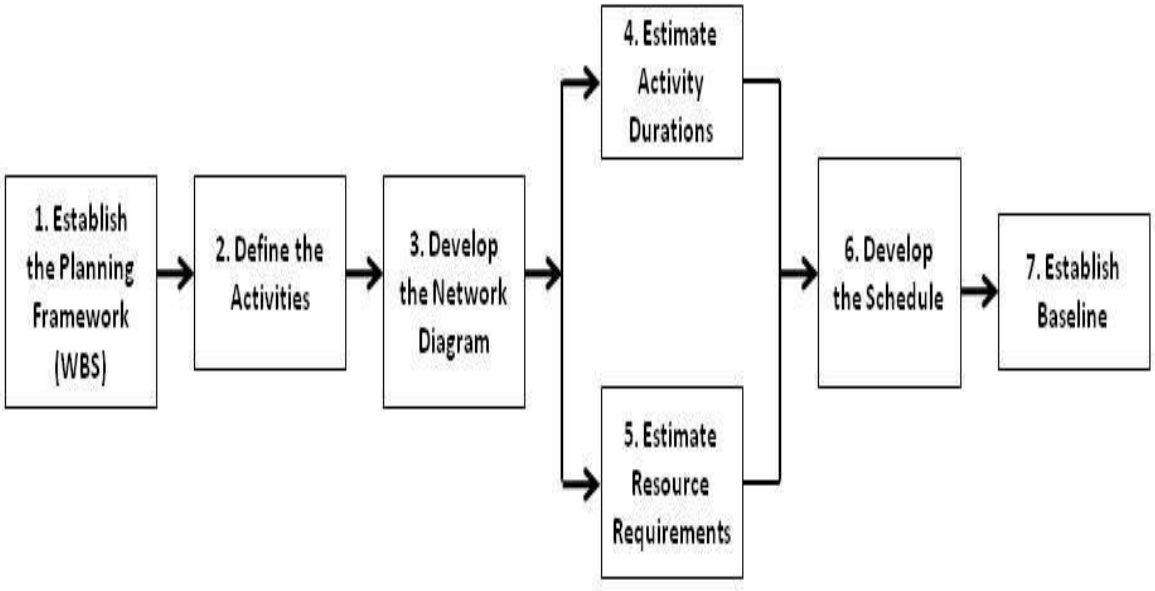


Fig. 28 The Seven-Step Process for Schedule Baseline Development

Step 1: Establishing the Planning Framework – The WBS

The WBS is the key tool in the planning phase to assist in work definition and to produce the framework for the plans and schedules. Planning work by WBS elements serves as the basis for estimating and scheduling resources requirements. The WBS assists in managing cost, schedule, and technical performance. By breaking the total product into successively smaller entities, management can ensure that all required products are identified in terms of cost, schedule, and performance goals.

The WBS Development steps include:

- Specify the project objectives.
- Identify specifically the deliverables to be provided to the customer.
- Identify other work area to make sure 100% of the work is identified.
- Subdivide the element into successive logical subcategories until the complexity and work effort in the elements become manageable units for planning and control purposes.
- The lowest level of the WBS is defined as the work package level. A work package provides a logical basis for defining activities or assigning responsibility to a specific person or organization.

Step 2: Defining the Activities or Tasks – The Basic Building Blocks

One of the most important steps is defining the project activities. Experience has shown that defining activities or tasks is not as easy as it looks. Too many times they are inadequately

defined, resulting in poor schedules and communication problems. Activity definition is extremely important as activities are the basic building blocs for planning and controlling the project. Make sure the need for the activity is communicated to the appropriate stakeholders, including those persons responsible for predecessor and successor activities as well as the person responsible for performing the activities. The activity may not be performed if it is not in the plan.

Step 3: Developing the Network Diagram

The identified activities must be sequenced and the relationship identified to support later development of a realistic and achievable schedule. This process is generally performed using project management software using the WBS as the framework. The network format scheme of choice is the Precedence Diagramming Method (PDM) which is used by most project management software programs.

Fig. 29 shows the precedence diagram method.

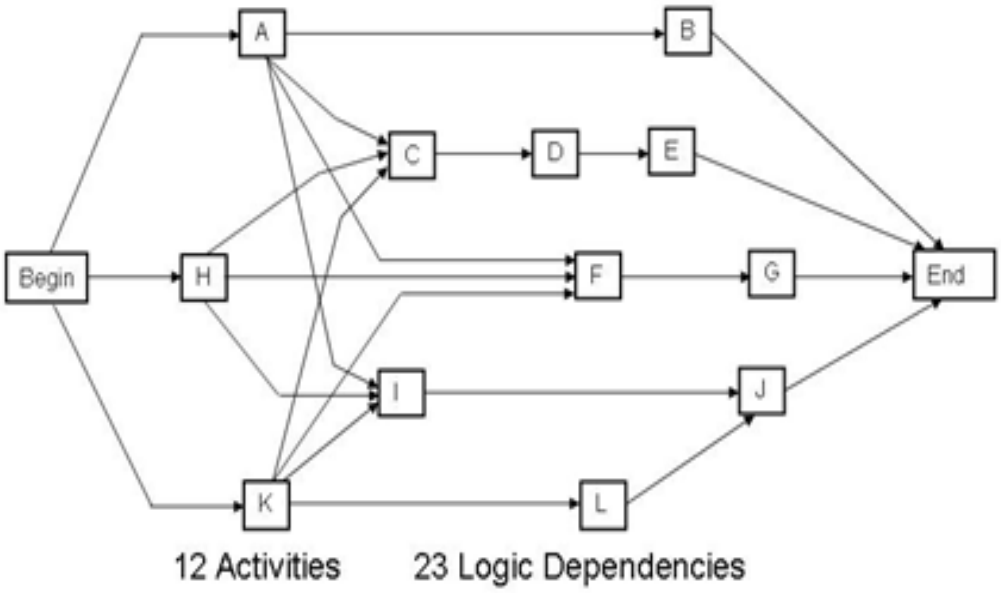


Fig 29. Precedence Diagram Method

Step 4: Estimating Activity Durations

Estimating activity duration involves assessing the number of work periods (time) needed to complete each identified activity. It is recommended that the person or group on the project team who is most familiar with the nature of a specific activity make or at least approve the duration estimate. To estimate the activity duration, historical data, expert judgment, experience and analogous estimating processes may be used. Information may be available from project files or commercial databases, but most often from project team members. Constraints and assumptions must be considered. Sometimes, activity durations are set in

advance or fixed, and the estimating involves determining the resources necessary to complete the activity within the set time.

Step 5: Estimating the Resource Requirements

Resources are required to perform work on projects. They require estimation and planning to identify their quantity and timing. When using computer software to assist in project scheduling, and activity durations must be estimated, the resources to be assigned to the activity should be estimated at the same time. Activity durations and assigned resources are closely related.

Step 6: Develop the Schedule

Schedule development involves determining planned start and finish dates for all project activities. If the start and finish dates are not realistic, the project may be high risk or uneconomic. Schedule development proceeds using the project network diagram, duration estimates, resource availability, project and resource calendars to identify non-work days, and various other constraints. These constraints can include imposed dates, key events, major milestones, etc. A preliminary milestone schedule is prepared based on the WBS and the project's milestone dates. This will serve as the project master schedule until the detailed planning is complete and the baseline schedule is issued. Particular attention must be paid to the reliability of any resource or activity duration assumptions, as invalid assumptions later become risks. Project management software should be used to assist with developing schedules. These products automate the calculations of mathematical analysis and allow consideration of many schedule alternatives. They also help prepare graphical description of the project schedules in varying levels of details, including network diagrams and Gantt charts.

Fig. 30 shows project schedule traceability of time management.

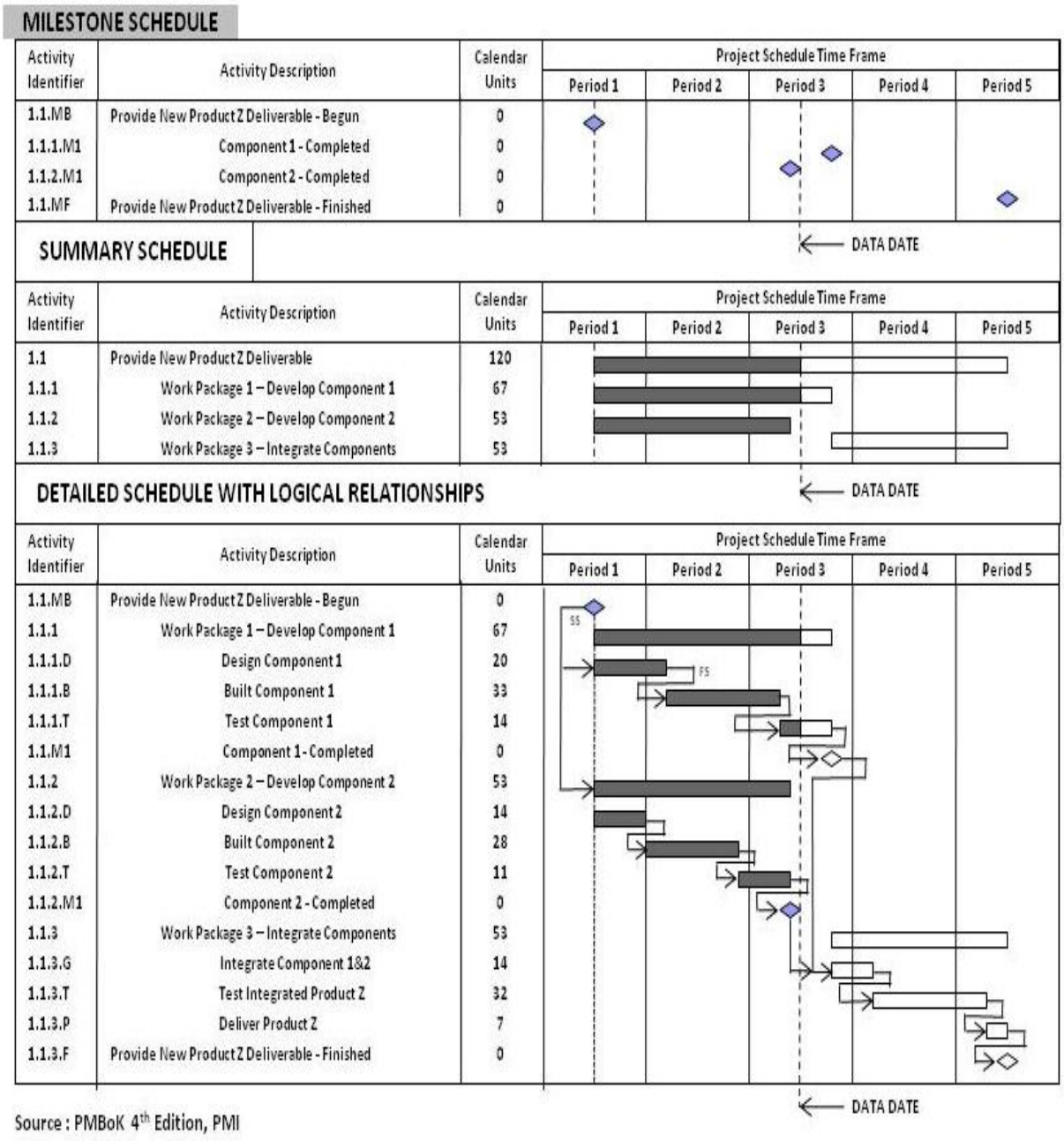


Fig. 30 Project Schedule Traceability

Step 7: Establishing the Baseline Schedule and Budget

The final step in the planning and scheduling process is establishing a coordinated and approved schedule referred to as the “baseline” schedule. Establishing a baseline officially marks the end of the planning phase and the beginning of the execution phase (EPC phase). The purpose of the baseline schedule is to establish an agreed-upon project schedule that can be used as the basis for work authorization, budgeting and control. It must be coordinated with all stakeholders, especially the customer/sponsor and organizations providing resources to support the schedule. The baseline schedule is a major component of the project plan.

Step 8: Controlling the Schedule (Time Management)

In executing project activities, the status of the project is monitored to update the project progress and manage changes to the schedule baseline. This activity involves determining the current status of the project schedule, influencing the factors that create schedule changes, determining that the project schedule has changed, and managing the actual changes as they occur. Performance reviews, project management software, resource levelling, what-if scenario analysis, leads and lags adjustment, schedule compression are techniques used to manage the time parameter in a project.

In managing time, the focus must be on the activities on the critical path to make sure they do not slip. To reduce the length of time planned for the total project, the duration of activities on the critical path needs to be reduced or the plan changed. As the duration of activities on the critical path is reduced, other paths may become critical as well. Similarly, during project execution, delays in activities on paths other than the critical path may result in other paths becoming critical.

“Total float or Total slack” refers to the amount of slack on the path where the particular activity is located. The “0” slack activities are on the critical path, and other values of slack indicate the amount of working time an activity on the path could be delayed before becoming critical. Non-critical paths may be adjusted or re-planned to the extent that slack or float exists without affecting the project completion date.

Quite often, the schedule must be changed to meet project constraints. Both schedule duration and resource allocations must be considered. Attack the critical path first by considering the following options:

- Reduce activity durations by taking a closer look at the estimates to reduce contingency.
- Adjust activity durations by considering probabilities, i.e., accept more schedule risk.
- Change the plan by altering precedence relationship, where feasible.
- In any event, compress earlier activities first to leave later options open.

“Free float or free slack” refers to the amount of slack any individual activity has and represents the amount it can move or float without affecting the start of any succeeding activity.

The amount of float that exists becomes important in adjusting the plan for resource conflicts. It is common when planning projects and assigning or estimating resources for each activity that certain persons are required for more than 100% of their time in a particular time period. If float is available, it can be used to adjust the timing of activities to resolve these problems.

The project manager should recommend for the Client’s review and acceptance of specific provisions for the handling of float throughout the various stages of the project, e.g., how

best to implement the Client's decisions related to how float is to be determined as well as float ownership.

Fig. 31 shows the Float concept in schedule management.

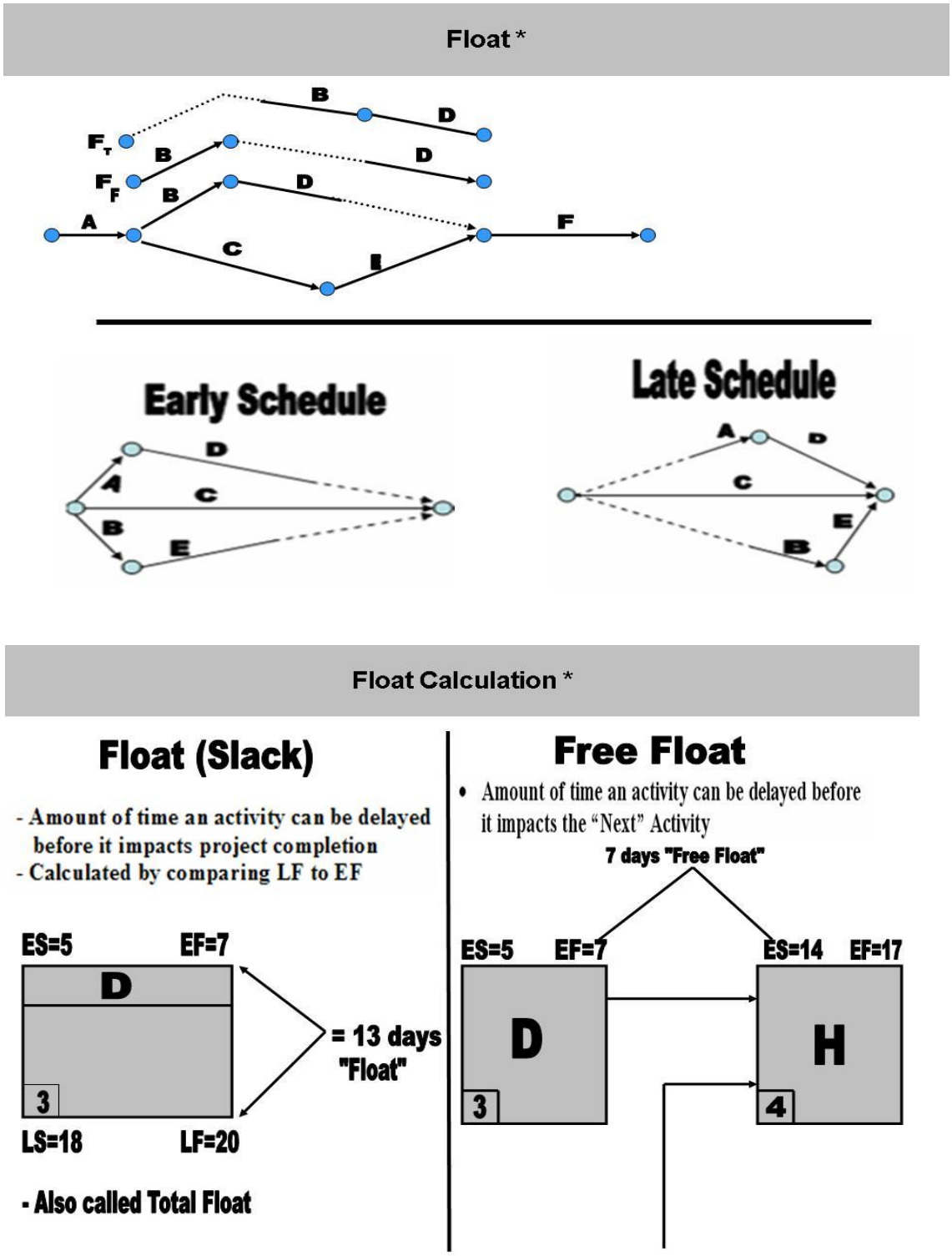


Fig. 31 The Time ``Float`` Concept

9.2 COST ENGINEERING (COST ESTIMATING/CONTROL)

Cost Engineering involves engineering practice where engineering judgement and experience are utilised in the application of specific principles and techniques to the problems of cost estimation, cost control and profitability. The success of any EPCC organization depends upon the organization's ability to complete its project on time, within budget and with a high level of quality.

To establish and control a fair value of budget, a comprehensive estimating, budgeting, monitoring, forecasting and reporting system is required. For effective cost control, it must reflect a continuous operation beginning with the very first conceptual "Order of Magnitude" estimate through the design, procurement, construction and commissioning phases to the final issue of a historic report after the project completion.

There are many factors involved in the cost estimating methodology. Once the purpose of a particular estimate is established, the type of information available must be investigated and the scope of the work to be covered by the estimate must be defined. The next step would be to determine the time and resources available for its preparation and the effort that must be provided. This, in turn, will establish what type of estimate would be produced and which procedure will be implemented, consequently determining the degree of accuracy that can be expected.

The following chart represents cost engineering during the project EPC life cycle and the different steps associated with different types of estimate required for cost control purposes. The types of estimates required to be prepared for proper planning and control of cost during the life of the project are illustrated in Fig. 32.

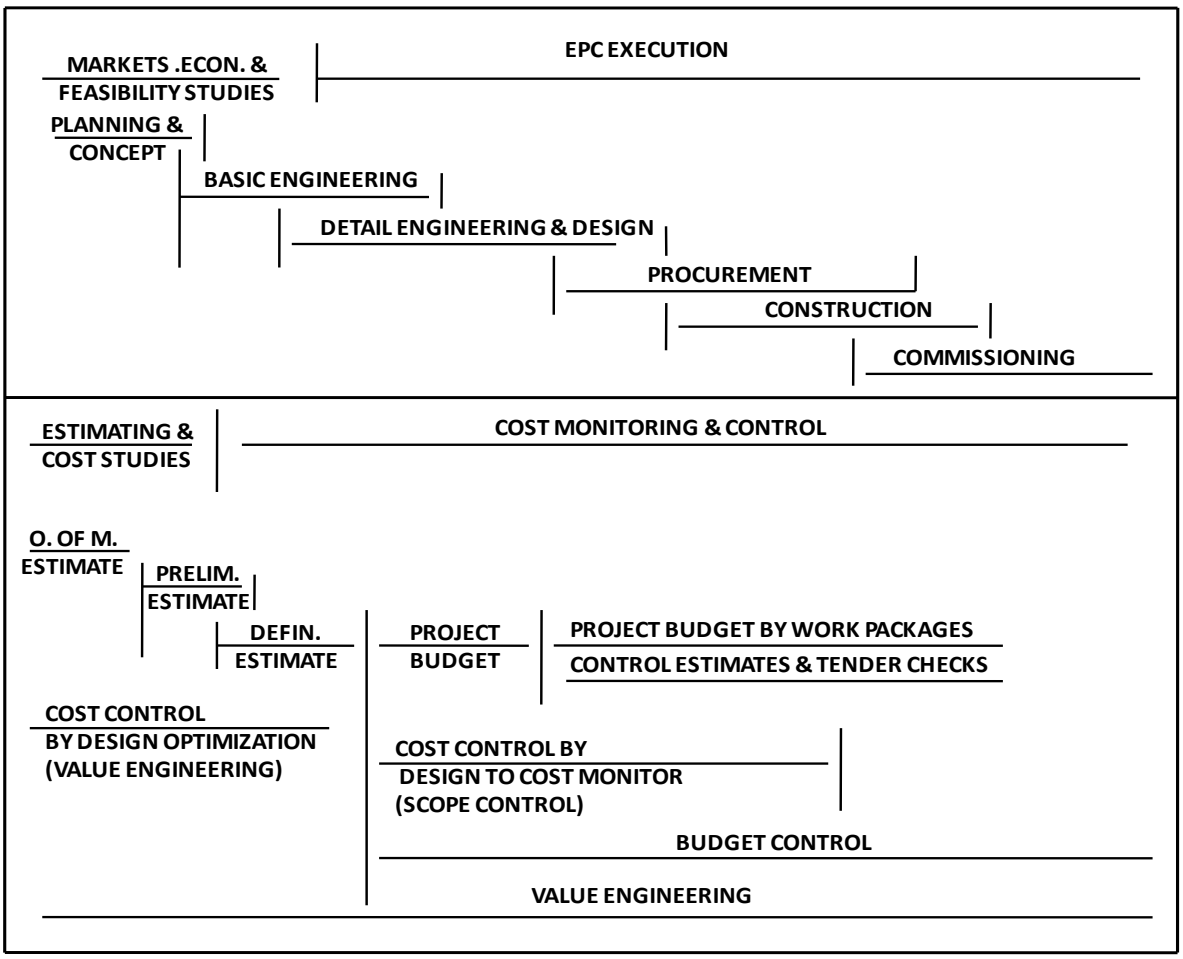


Fig. 32 Cost Engineering During The Project EPC Life Cycle

Step 1: "Order of Magnitude" Estimate

This estimate gives a "rough" indication of the total cost, usually prepared during the conceptual or feasibility phases. The type of available information is very limited, the scope is vague and indefinite and factoring costs and other pertinent data from similar past or current projects are used. The resulting costs are adjusted to reflect anticipated project conditions. This type of estimate will give a global assessment of project costs. This quick, informal educated guess of the cost magnitude of the project would usually have an accuracy range of plus or minus 25% to 30%.

Step 2: Preliminary Estimate

This estimate is prepared from preliminary, basic engineering data such as technical design criteria, basic outline of process and services requirements, preliminary equipment lists, some layouts, conceptual quantities and preliminary take-off. Budget quotes are obtained for major equipment. Other costs are based on factors, and current price lists. Regional

labour productivity, indirects, cost escalation and market conditions are studied and taken into consideration.

The flow sheets, however, are not frozen yet, the capacity of the major equipment is only approximative, and the project team is still carrying out studies to establish the most operational technical features for the most economical price. The expected accuracy range of such an estimate is plus or minus 15% to 25%

Step 3: Definitive Estimate

This estimate is prepared when concept and scope are established, and basic engineering is substantially completed. Required are project plan, schedule and specifications, plot plans, process flow sheets, general layouts, equipment lists, major piping runs, electrical single line diagrams and P&I diagrams. Soil investigations have been carried out, architectural features are established. This is the key estimate in the life of a project and constitutes the planning document for the "Cost" parameter by defining the scope and cost of the project. Prepared during the last stages of the planning phase, it establishes the "Target Cost" and is used as a yardstick for cost control purposes throughout the entire EPC execution phase. It is used in the development of detailed project plan, specification and schedule and especially in the preparation of the project budget. An analysis of project risks is carried out to determine the amount of contingency allowance to cover items of work which, by experience, it is known that they will have to be performed but can't explicitly described at the time of the estimate, due to lack of details. A definitive estimate is expected to have an accuracy range of plus or minus 10%.

The Project Manager and his project team have to live with the scope and cost as defined in the Definitive Estimate. Consequently, a spirit of responsibility is created in the team by having all project engineers and their functional responsibilities review and agree with the section related to their discipline. The estimate is also reviewed in depth by the management and the client's representative for approval.

Step 4: Control Estimate

This is an estimate of a part of a project for which the design has progressed to a point where costs can be very accurately determined, e.g., estimates for parts of the project as detail design progresses to points of 50% and/or 75% advancement. These estimates are used to assist engineers to control the scope and costs as established in the Definitive Estimate, and to ensure that the design remains compatible with the target cost. During the preparation of these control estimates, when divergences from scope and cost are pinpointed, they are reported immediately to the responsible project key manager and the project manager for remedial actions. Such cost divergences are also incorporated in the monthly cost forecast to keep Management and the Client properly informed. The methodology of Control Estimates is based on the policy of "Design-to-Cost" and on the

strong belief that cost control is vitally required in the planning and design stages when decisions are made which significantly affect the cost, and when there is still time to change these decisions, if they are found to upset the balance between the three parameters of Quality/Scope (Performance), Time and Cost.

Step 5:

Tender Check Estimate (TCE)

This is a detailed cost estimate prepared for each "Request for Tender" package, in conformity with the bid specifications and conditions on the same basis as all other bidders. This type of estimate should reflect the fair market value of the job, for use in the evaluation and analysis of contractor's bid or to assist in negotiation for adjustments and extras.

The cost control function in project management is to provide the necessary tools to the project manager and his key managers who should take corrective actions in case of scope, quality, quantity and cost variations. The process of reporting these variations on time and the associated corrective actions as well as the realistic and honest forecasting of cost status form the basis of Cost Control.

Cost Control in project management is a continuous operation, beginning with the planning phase with assistance to adapt the codification system to the requirements of the project, continuing with incorporating the input of the Definitive Estimate into the computerized system and reaching its peak of cost monitoring and reporting during the EPC execution phase. It is well advised that a performance tracking system be in place and integrated into the Cost Control function to measure current cost status and forecast cost trends as the work progresses. Although formal cost forecast reports are usually issued on a monthly basis, early warning bulletins at pre-determined variance levels are of great importance. Earned Value Management (EVM) is used as an effective tool used to control cost in a project (Refer to Performance Tracking section below).

Cost Forecast reports are summarized and sorted in different breakdowns to permit proper analysis by different level of project team members, Management and Client.

A summary by subdivision will permit grouping major systems or areas, thus advising area managers of forecasted cost variances within their areas of responsibility. A summary by contract package will help Procurement and Construction to assess the magnitude of work packages in the detail planning of execution and will also provide trending of the forecast.

A summary by Discipline is one of the most important summaries of the system as it alerts project discipline engineers to the need for corrective measures should the design exceed the target cost. The target cost which is the result of the Definitive Estimate forms the yardstick of comparison and does not change after its approval. However, it is revised under another column to record justified and approved changes of scope. The commitments are

the result of the input from the Commitment and Holdbacks and Payment status reports from Project accounting functions.

The key to factual and realistic forecasting is the development of the "Estimate to Complete" (ETC) figures. The ETC is updated on a continuous basis, using all the latest information available, including control estimates, bid tabulations, contract awards, purchase orders, contractor's claims, cost trends, anticipated claims, quantity take-offs, field labour forecasts, etc. The "Commitments" added to the ETC produce the best forecast of the total cost at the time of the report. The forecast is compared with the Revised Target to identify under-runs or overruns for each coded components of the project.

Fig.33 shows a typical Cost Report and Forecast.

PROJECT CODE	DESCRIPTION	COMMITMENTS	EST .TO COMPLETE	TOTAL FORECAST	REVISED TARGET	VARIANCE AMOUNT	TARGET COST EST.
0	PR. MNGT SERVICE						
1	EARTHWORK						
2	CONCRETE						
3	STRUCTURAL STEEL						
4	ARCHITECT COMPONENTS						
5	EQUIPMENT						
6	PIPING						
7	ELECTRICAL						
8	INSTRUMENTATION						
9	CONSTRUCTION INDIRECTS						
	TOTAL						
	TOTAL M AT'L & LABOR						
	CONTINGENCIES						

Fig. 33 Cost Report And Forecast (Summary By Discipline)

9.2.1 CHANGE ORDERS IN COST CONTROL

Change orders document changes from the original scope of the contract, confirm schedule revisions, and set forth other modifications. The change order is generally written on a standard form and includes a complete but concise description of the change and its effect upon the contract schedule and price. Once it is agreed that a revision to the contracted scope of work is required, there should be an adjustment to the contract price or time, or both. Determining a fair and equitable adjustment amount is a matter of obtaining a review of supporting data as proof of costs. Organization of the data and a thorough understanding of the scope of the change order are integral in the review process. An estimate of the cost of the change order listing the anticipated labour, material, equipment, subcontract work, contractor's overhead and profit, as well as any justified impact costs. Special attention

should be given to reductions in the scope of work because there can easily be overlooked. The effect of the change on the schedule should be analyzed for time impact.

Change order requests are normally reviewed by the construction manager, who normally compares them with his own fair-cost estimate of the change. After his review, and after negotiation with the contractor if required, the manager may recommend acceptance by the Owner, who in turn will formally approve and execute the change order.

Upon the receipt of a claim by a supplier or contractor, the contract administrator will advise the project cost engineer or the site cost engineer (in case of field-originated claims) of the claim and will assure that the cost engineer will have all the facts as well as all necessary documentation to enable him to produce a detailed and fair evaluation of extra work performed. The project cost engineer will insure that the contract administrator will receive a detailed estimate and written report, substantiating the validity of the claim and give the contract administrator the necessary quantity and cost information to be able to negotiate a fair deal.

9.2.2 CASH FLOWS IN COST CONTROL

The cash flow of a project is the distribution over time of the estimated amount of the capital cost. There are two types of cash flows:

- The traditional cash flow is the distribution over time of funds which will be disbursed to pay the contractors.
- The cash flow is the distribution over time of costs which will be incurred.

Both types of cash flow are project management tools to be provided by Cost Engineering, during the planning and execution phases of a project, as required. The cash flow will provide the information to the Client on the timing of his financial arrangements to meet capital cost payments.

The cash flow generated to develop cost escalation must be based on the cost flow since the escalation is relevant with the distribution of costs which will be incurred.

The cash flow, in general, is a schedule showing where and when project execution costs may be expected to go.

In preparing a cash flow calculation, the first step is to reduce the project master schedule into a bar chart schedule. Then, the estimated costs of various components of the project will be spread based on the bar chart schedule on a monthly or quarterly increment. The generated increments are accumulated to produce a cumulative cash flow curve.

Fig. 34 shows the Cash Flows Expenditures.

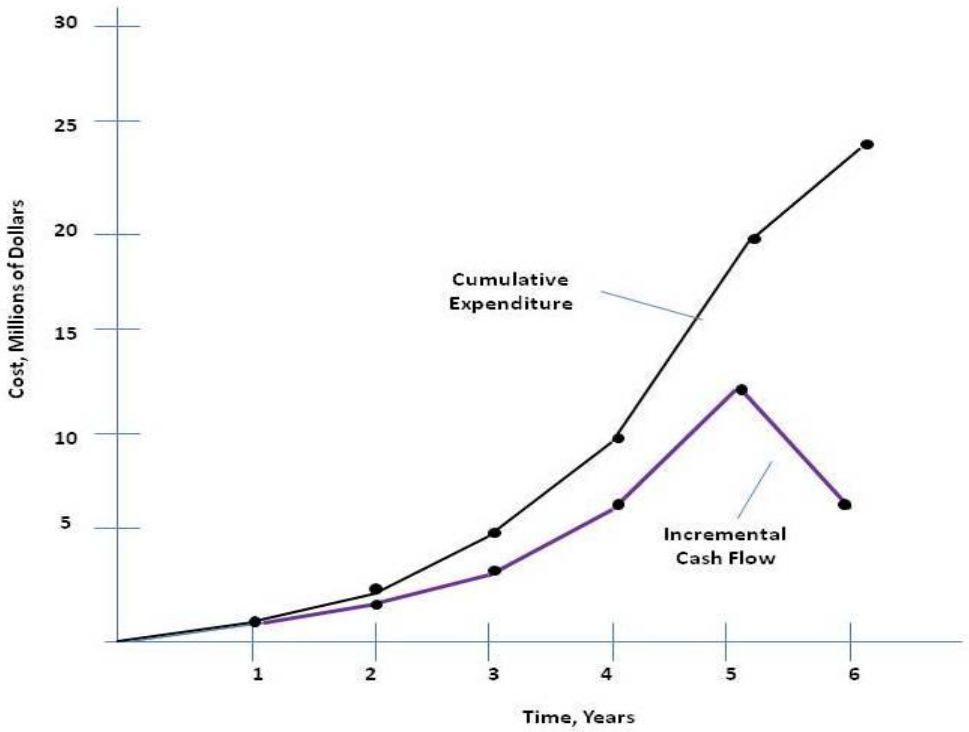


Fig. 34 Incremental and Cumulative Expenditures (Cash Flows)

9.3 STAKEHOLDERS MANAGEMENT

Stakeholders Management must be executed as per what was planned for in the planning phase. Project managers must deal with a multitude of stakeholders, all with varying perceptions of value. As a result, managing and balancing stakeholders' needs can be extremely difficult. Making a decision to maximize the value of one stakeholder could severely alienate other stakeholders. The project manager will occasionally be required to make decisions that benefit some stakeholders more than others, and there is a risk that some decisions will result in conflict which must be resolved by the process of negotiation. A key characteristic of stakeholders management is that early in the project, the stakeholder can have a great deal of influence, but as the project goes on, their level of influence minimizes. Some key areas of stakeholder management that need to be considered include the identification and analysis of the stakeholders and their goals or agendas for the project, i.e., The project manager and his project team should ensure that all stakeholders are identified and that the influence of each stakeholder as it relates to the project is fully understood. It is also important that key stakeholders are included on the project as needed so that they have appropriate input and contribution as the project evolves. Finally, when activities are complete, the appropriate stakeholders sign off and approve the project work so that project participants can move on to the next project.

9.4 COMMUNICATION MANAGEMENT

The main focus is to deliver information to the right project stakeholders. Information about project work and activities are communicated as a result of the communication plan criteria and work results. These results are distributed to the various stakeholders in the frequency and the format as specified by the communication plan. Key tools and techniques include:

- Communication Skills and Information Gathering: These help create the distribution environment for the information on the project.
- Information Retrieval Systems: Systems that allow team members access to key project information. These can include filing systems, databases, project management software and software that provides the opportunity to access schematics or other technical drawings.
- Information Distribution Methods: Methods used to get project information to project personnel. These can include meetings, paper work, network access, e-mail, voice mail, etc.
- Lessons Learned: These are used to analyze what worked and didn't work well on the project so that historical information for future projects can reflect this knowledge.

10. PROJECT CONTROL

Project Control involves activities performed to observe project execution so that potential problems can be identified in a timely manner and corrective action can be taken, when necessary, to control the execution of the project. Project performance is observed and measured regularly to identify variances from the project plan. It includes tracking project activities against the project plan and the project performance baseline and influencing the factors that could circumvent integrated change control so that only approved changes are implemented.

The technique to be used for the measurement, tracking and reporting of the actual progress and performance of the project is the Earned Value Management (EVM). It is a project planning and control system that goes beyond the traditional concept of comparing the amount of project time elapsed against the amount of actual cost spent to give a comparison of actual value of work accomplished against the planned value of work scheduled. It does this by incorporating the Earned Value methods into the more widely used management principles of initiating, planning, executing and controlling work within a project.

10.1 PERFORMANCE MEASUREMENT & TRACKING (EVM)

The purpose of performance measurement & tracking is:

- To maintain the project's cost, schedule, and forecast status including their correlation with technical achievement.
- To show how cost, schedule and technical performances are measured, tracked and used for project management and control purposes.

The EVM concept requires a planned value performance measurement plan, typically represented by the project's scheduling system, and earned value measurement against the planned value, which is also a fall-out of the scheduling activity as related to the actual costs spent to accomplish this same physical (earned value) work. Hence, it is based on the measurement of the budgeted value of the work actually carried out and its comparison with the budgeted value of the work that should have been carried out and what is actually costs. EVM provides project managers with a type of early-warning buzzer that allows them to take necessary corrective action if the project is spending more money than it is physically earning.

Basically EVM consists of the following steps:

- **Step 1**: Define the Scope of the Project with the Use of a Work Breakdown Structure (WBS).
- **Step 2**: Determine who will perform the defined work, including the identification of all major critical procurements.
- **Step 3**: Plan and schedule the defined work.
- **Step 4**: Estimate the required resources and formally authorize budgets.
- **Step 5**: Determine the metrics to converse Planned Value into Earned Value.
- **Step 6**: Form a project baseline, determine the points of management control called Control Accounts, and formally authorize Control Account Plans (CAPs).
- **Step 7**: Record all direct project direct costs consistent with the authorized baseline budgets, in accordance with the organization's general books of accounts.
- **Step 8**: Continuously monitor the earned value performance to determine cost and schedule exceptions to the baseline plan: the schedule variances and the cost variances
- **Step 9**: Using earned value data, continuously forecast the final required cost based on actual performance, and keep management apprised so it can take corrective actions if necessary.
- **Step 10**: Manage the defined scope baseline by approving or rejecting all changes, and then incorporating the approved changes into the project baseline in a timely manner.

Figures 35 and 36 show the Establishment of Control Account and Performance Measurement Baseline.

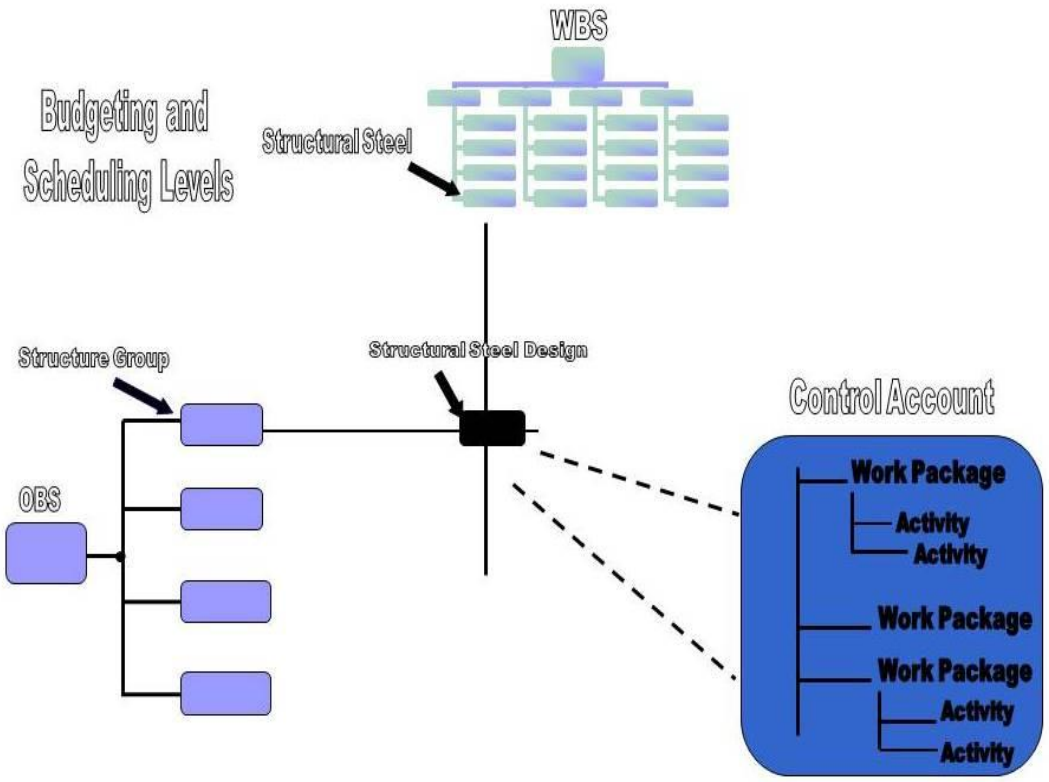


Fig. 35 Establishment Of Control Account

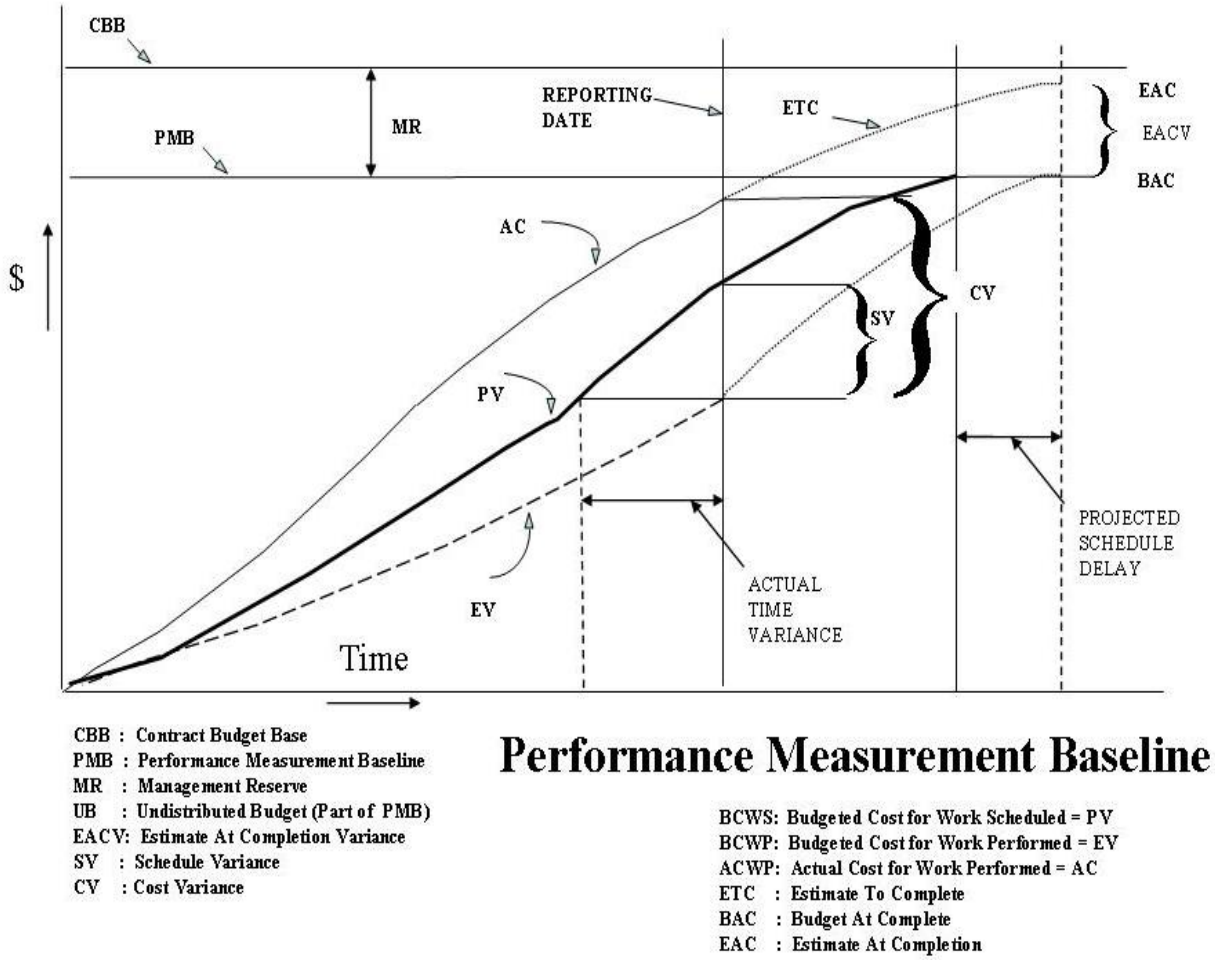


Fig. 36 The Performance Measurement Baseline

10.2 PERFORMANCE ANALYSIS AND REPORT

The Planned Value (PV), Earned Value (EV) and Actual Cost (AC) are used for the calculation of the following work progress and performance data:

- **Schedule Variance (SV) = EV – PV**

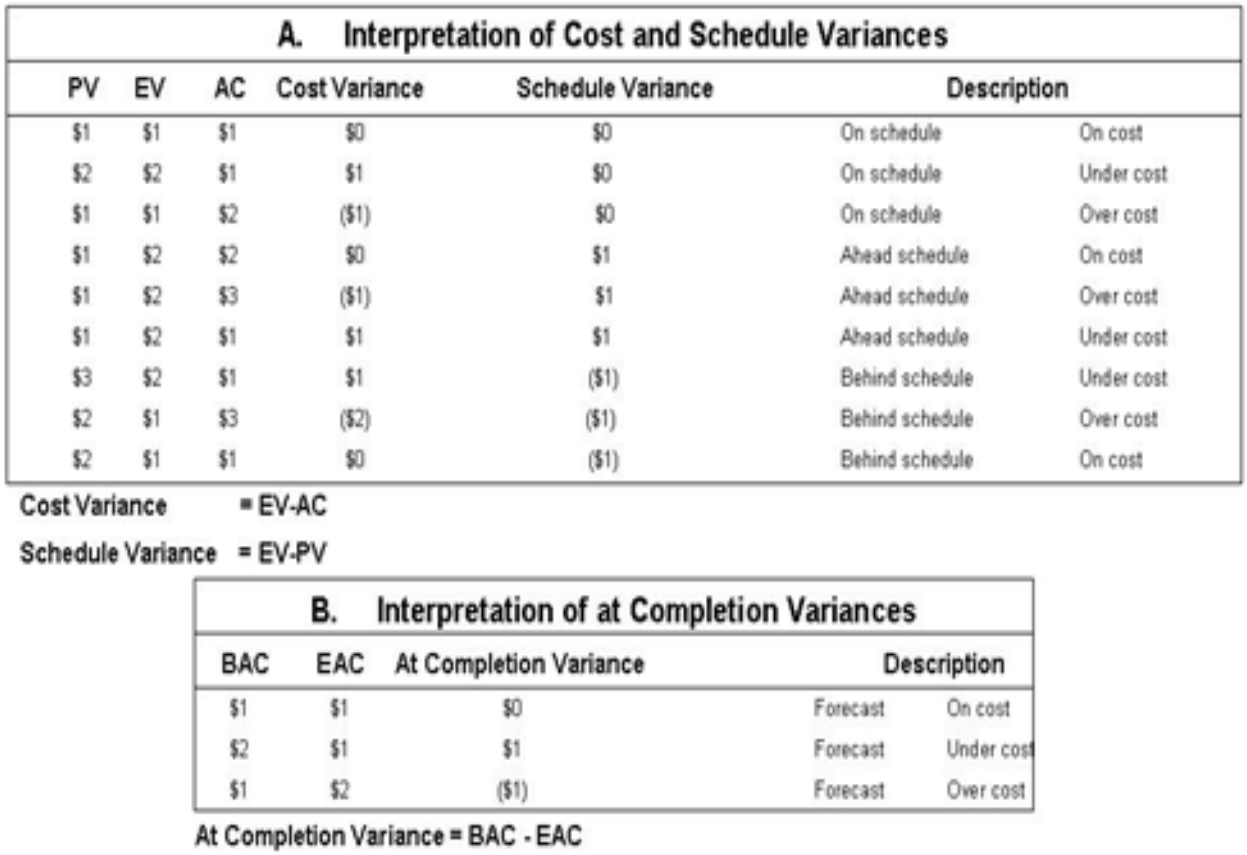
  This variance is a measure of schedule performance, i.e., the difference between work actually accomplished according to the actual schedule and work scheduled to be accomplished according to the baseline schedule.

  Negative values are considered to reflect progress below the scheduled target and positive values indicate that more work is being accomplished than was expected. A variance equal to zero shows progress is right on target.

- **Cost Variance (CV) = EV – AC**

  This is a measure of project performance in accomplishing the required work within the budget allocated to perform that work. Negative variances are considered to reflect performance below what was expected and positive variances are regarded as showing good performance.

Fig. 37 shows the interpretation of Earned Value Data.



A. Interpretation of Cost and Schedule Variances

PV	EV	AC	Cost Variance	Schedule Variance	Description	
$1	$1	$1	$0	$0	On schedule	On cost
$2	$2	$1	$1	$0	On schedule	Under cost
$1	$1	$2	($1)	$0	On schedule	Over cost
$1	$2	$2	$0	$1	Ahead schedule	On cost
$1	$2	$3	($1)	$1	Ahead schedule	Over cost
$1	$2	$1	$1	$1	Ahead schedule	Under cost
$3	$2	$1	$1	($1)	Behind schedule	Under cost
$2	$1	$3	($2)	($1)	Behind schedule	Over cost
$2	$1	$1	$0	($1)	Behind schedule	On cost

Cost Variance = EV-AC

Schedule Variance = EV-PV

B. Interpretation of at Completion Variances

BAC	EAC	At Completion Variance	Description	
$1	$1	$0	Forecast	On cost
$2	$1	$1	Forecast	Under cost
$1	$2	($1)	Forecast	Over cost

At Completion Variance = BAC - EAC

Fig. 37 Earned Value Data Elements Interpretation

- **Resource Variance (RV) = AC – PV**

  This is a measure of whether or not the project is being adequately staffed in order to carry out the work. It answers the question: “Are the resources being applied at a rate consistent with that called for in the budget plan?”. Negative variances indicate that the project is being understaffed in comparison with the budget plan, and positive variances indicate overstaffing.

- **Cost Performance Index (CPI) = EV/AC**

- **Schedule Performance Index (SPI) = EV/PV**

  - CPI represents the delicate relationship between the dollar value of the earned value physically accomplished versus the actual costs incurred to accomplish the work. A CPI performance of less than 1.0 indicates that the project is experiencing a cost overrun for the work it has accomplished.

  - SPI represents how much of the original scheduled work has been accomplished at a particular point in time. It is a reflection of the work being done according to plan, or falling behind the plan. An SPI performance of less than 1.0 indicates that the project is running behind the dollar value of the work that it sets out to accomplish.

Performance Indices indicate the “efficiency” with which work has been accomplished.

Fig.38 shows the ramification of SPI and CPI in project performance.

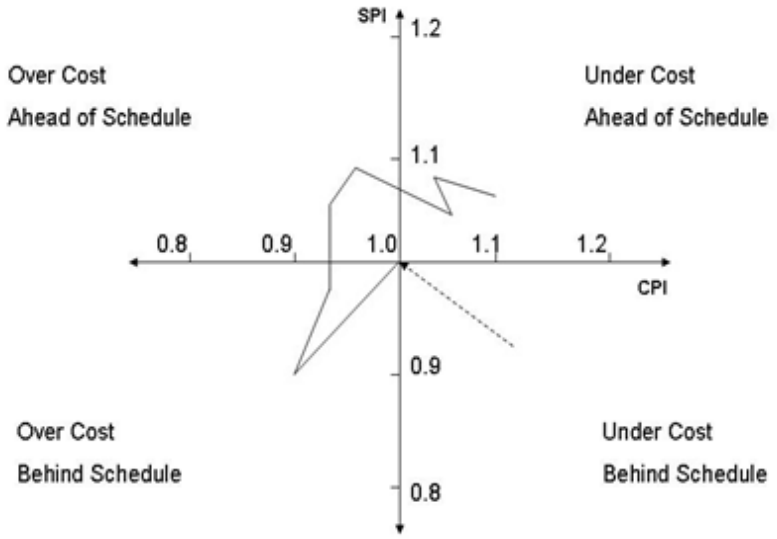


Fig. 38 Cost Performance Index v/s Schedule Performance Index

Numerous techniques are being used to predict the EAC, many are based on performance indices derived from values of past project performances. The most frequently methods are:

- **EAC = Actual Costs + ETC (Estimate To Complete)**
- **2. EAC = BAC/PF** where PF (Performance Factor) = CPI
- **3. EAC = Actual Costs** cum **+ (BAC – EV cum)/PF**

  where BAC – EV cum = Remaining Work PF (Performance factor) = CPI
- **4. The "floating average"** technique for EAC calculation:
  - **EAC = AC cum + (BAC – EV cum)/CPI* n**
  - **CPI*n = (CPI n + CPI n-1 + ...CPI 1)/n**

  Where n= Number of months!
- **5.** The **"most accurate"** formula:
  - **EAC = AC cum + BR/ ((.2 x SPI cum) + (.8 x CPI cum))**

  Where AC is the Actual Costs
  BR = Budget Remained = BAC – EV cum
  EACV (Estimate At Completion Variance) = EAC – BAC

Hence, the EVM concept is the cornerstone of work progress and performance tracking and measurement method.

Templates are standard yardsticks for progress measurement while work on deliverables is in progress. The methodology entails breaking down the work on the deliverables into a number of verifiable phases called control points, and to allot to each of these phases a

progress percentage expressed in percent of the cumulative EV of the work. The definition and number of phases or control points, as well as the progress percentage allotted to them depend on the document type, the engineering discipline and the specific project requirements.

For example, typical control points and the corresponding work contents for most engineering deliverables are:

Work: Design Drawings

Work Content	Release Status	Cumulative WT% Earned
Designed	Started	0
Design concept finalized	Released for internal review	20
Internal comments incorporated; checks against preliminary vendor drawing	Released for Client comments	60
Client's comments incorporated	Released for Bid	70
Final check completed	Released for Construction	90
Work completed		100

Figures 39 and 40 show the PMP Establishment and a typical EVM Executive Summary Report.

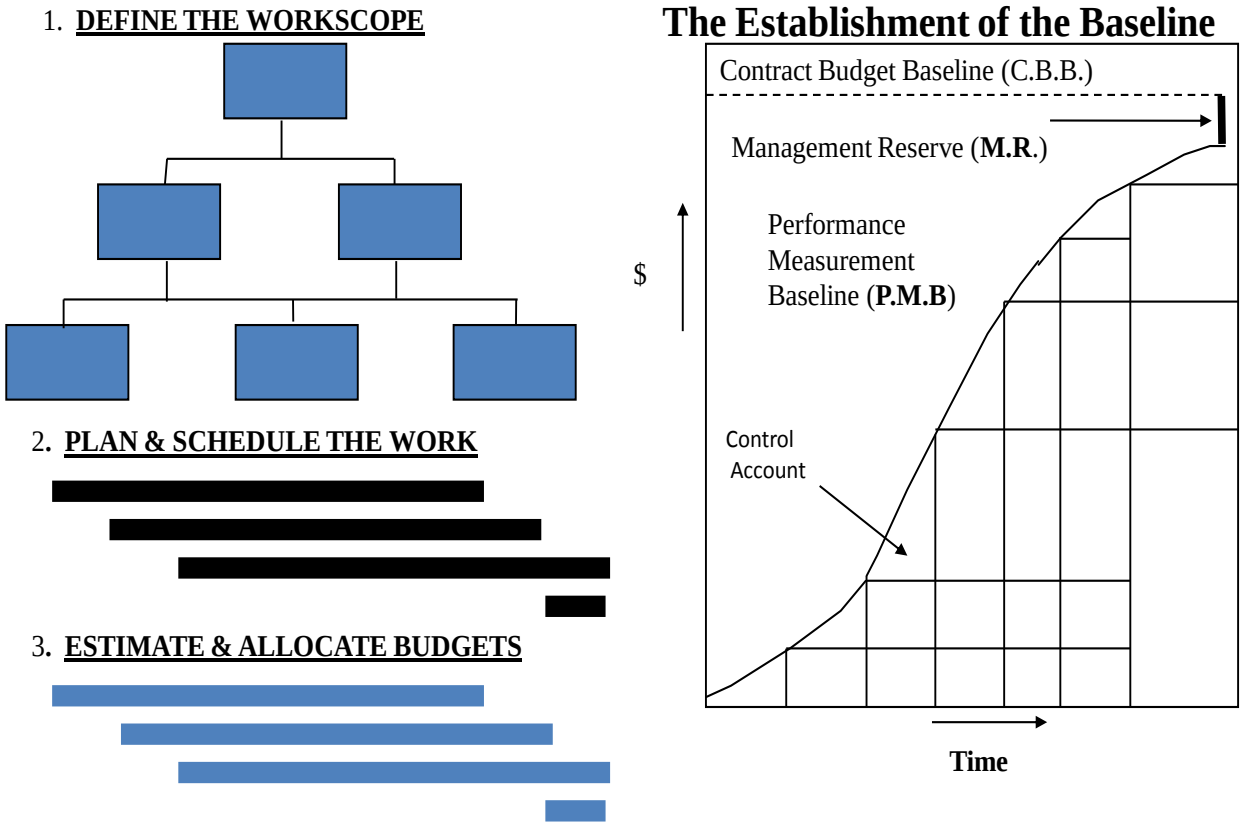


Fig. 39 The Performance Measurement Baseline (PMB) Establishment

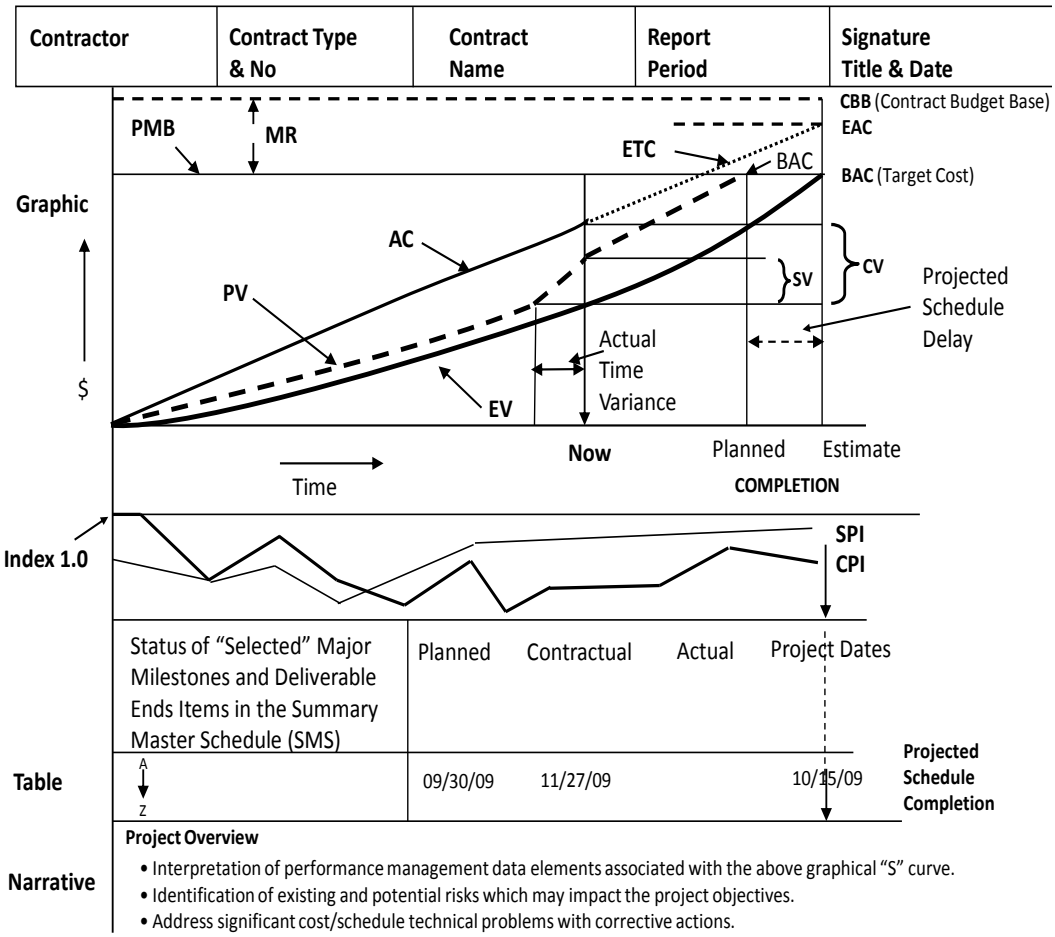


Fig. 40 EVM-Executive Summary Report

10.3 QUALITY MANAGEMENT

Quality management is defined as the fulfillment of project responsibilities in the delivery of products and services in a manner that meets or exceeds the requirements of the project participants (the Owner, the Designer and the Constructor). It includes the effective application of QA/QC (Quality Assurance/Quality Control) measures:

- **Quality Assurance:** Planned and systematic actions to help assure that project components are being designed and constructed in accordance with applicable standards and contract documents.

- **Quality Control:** The review of project services, construction work, management, and documentation for compliance with contractual and regulatory obligations and accepted industry practices.

As quality means different things to different members of the project team, Owners, designers and constructors place different value on the durability, operational features, configuration flexibility, initial capital investment, life cycle costs and other characteristics of project. Hence, effort should be concentrated on examining the appropriate role performed by these people to assure that project design and construction meet the quality goals and objectives of the project team under the traditional design-bid-build project delivery.

10.3.1 THE OWNER'S ROLE

The Owner is the central figure in promoting initiatives and activities to achieve project quality. QA/QC activities for Owner include:

- Supply a project specific QA/QC plan to the design professional and constructor with instructions to tailor their existing generic QA/QC plans to conform to the Owner's plan.
- Require the design professional and constructor to adapt existing generic QA/QC plans to the project objectives.
- Require the design professional to write a design QA/QC program.
- Require the constructor to write a construction QA/QC program.

10.3.2 THE DESIGNER'S ROLE

QA/QC activities for the Designer typically include measures to enhance creative processes, clarify communication among team members, and develop project concepts to a level of design detail sufficient for the constructor to effectively transform the design into physical structures. Most design professionals already have QA/QC plans for typical design activities in place. The design professional usually adapts and expands the existing program to meet the unique objectives of the project at hand. Typical designer' QA/QC plans call for the submission of reports and supporting documentation at specified intervals, usually at completion of a major design milestone.

The Designer's QA/QC activities evolve with the advance of project design. Therefore, the Designer and the Owner benefit from a QA/QC plan that provides the flexibility to focus on meeting the Owner's project quality goals during different phases of a project. These phases and activities are:

- Pre-Design: During this phase, the parties define their relationship, establish project parameters, and negotiate the agreement for professional services. In addition, the Owner and the Designer agree on a project-specific QA/QC plan during this phase.
- Schematic Design: QA/QC activities during this phase include the investigation of design alternatives that satisfy the design parameters, constraints, space and regulatory guidelines, and procedures for communicating with the Owner. An important element of QA/QC is Owner acceptance of a schematic design report prepared by the Designer.

- Design Development: QA/QC activities during this phase include the refinement of design alternatives and cost estimates to confirm that they satisfy the requirements. An important element of QA/QC is the approval of the design development report prepared by the Designer. Following this approval, the design is frozen, after which no more significant changes are allowed so that the contract documents focus on a single design.

- Contract Documents: With the design frozen, the design team maintain control over changes so that they may produce consistent technical specifications and other construction documents.

- Bidding: QA/QC activities during this phase include responding to questions from the bidders, review of the bids received for conformance with the requirements of the bidding documents, and evaluation of the bid tabulations.

- Construction: During construction phase, the Designer's QA/QC role includes the technical review and approval of constructor submittals under the contract.

- Design Reviews and Audit: QA/QC activities assure appropriate design quality by identifying unsound concepts, analyzing constructability, eliminating redundant activities, providing benchmarks for cost and schedule, and aiding interdisciplinary coordination.

- Pre-Bid Conference: QA/QC activities include providing accurate and forthright information about project conditions and the bidding documents.

- Bid Evaluation: QA/QC activities include careful review to ensure that each bidder has complied with the bid requirements.

10.3.3 THE CONSTRUCTOR'S ROLE

The constructor (contractor) is responsible for implementing QA/QC during the construction phase to meet the terms of the Owner-Constructor agreement. The constructor QA/QC plan is often quite complex because the constructor is responsible for the activities of subcontractors, material suppliers, manufacturers, fabricators, and vendors as well as his/her own activities. The constructor must also take into account the interest and participation of public agencies that enforce building codes, oversee the handling of toxic and hazardous materials handling, enforce storage and disposal regulations, grant permits, and enforce other regulations that affect construction. The constructor's QA/QC activities include:

- **Meeting contractual provisions:** The contract documents represent the minimum level of quality to be achieved by the constructor. They define standards and materials of construction, expectations for the execution of the work, performance criteria and testing of equipment assemblies and systems, and the documentation necessary to demonstrate that these contract provisions have been met. QA/QC measures are geared

to avoid delays by subcontractors, the constructor, the designer and the Owner during the contract submittal, review and approval processes.

- **Project-Specific Needs:**

  - Measures to ensure that subcontractors are qualified, certified and/or licensed as required.
  - Procedures for the inspection, control and timely delivery of purchased materials, equipment and services.
  - Identification, inventory, and storage of materials, parts, and components pending incorporation into the project.
  - Control of measuring and test equipment.
  - Segregation of records specified by contract and required by the constructor's QA/QC program to furnish evidence of activities affecting quality.

Quality management involves many details, measures, and submittals; all of which serve the goal of improving project quality. To make quality management measure work during project supervision and contract management, project participants should communicate regularly. Quality management processes, hence, involve mutual understanding among participants of their respective concerns and accomplishments, as well as commitment to resolve problems quickly and equitably.

Quality Management also provides an umbrella for another important quality activity, i.e., Continuous process improvement. This activity provides an iterative means for improving the quality of all processes by reducing non-value added project activities, which allows project processes to be operated at increased levels of efficiency and effectiveness. The Japanese word kaizen (meaning continual, incremental improvement) is widely used in quality-related activities.

10.4 INTEGRATED CHANGE CONTROL

The process of reviewing all change requests, approving changes and managing changes to the deliverables, project documents and project plan. The integrated change control process is conducted from project inception through completion. The project plan, the project scope statement, and the deliverables are maintained by carefully and continuously managing changes, either by rejecting changes or by approving changes by assuring that only approved changes are incorporated into a revised baseline.

Integrated change control process includes the following change management activities in differing level of detail, based upon the progress of project execution:

- Influencing the factors that circumvent integrated change control so that only approved changes are implemented.
- Reviewing, analyzing, and approving change requests promptly, as a slow decision may negatively affect time, cost or the feasibility of a change.

- Managing the approved changes.
- Maintaining the integrity of the baselines by releasing only approved changes for incorporation into the project plan and project documents.
- Reviewing, approving, or denying all recommended corrective and preventive actions.
- Coordinating changes across the entire project, e,g., a proposed schedule change will often affect cost, risk, quality and staffing.
- Documenting the complete impact of change requests.

Changes may be requested by any stakeholders involved with a project. Every documented change request must be either approved or rejected by some authority within the project management team or an external organization. Whenever required, the change control process includes a change control board responsible for approving or rejecting change requests. The roles and responsibilities of these boards are clearly defined within the change control procedures, and are agreed upon by appropriate stakeholders. Approved change requests can require new or revised cost estimates, activity sequences, schedule dates, resource requirements and analysis of risk responses alternative. These changes can require adjustments to the project plan. A configuration management system with integrated change control provides a standardized, effective and efficient way to centrally manage approved changes and baselines within a project. Configuration control is focused on the specification of both the deliverables and the processes while change control is focused on identifying, documenting and controlling changes to the project and product baselines.

10.4.1 PROJECT CHANGE NOTICES (PCNS)

Project Change Notices (PCN's) are the basis for approval of changes to the scope of work and subsequent adjustment to the project budget, schedule and forecast.

A request for a change to the scope of the work may originate from the Client or any project discipline at any phase of the project. It will originate as a Design change Notice (DCN) transmitted to the cost engineering group. Not all DCN's end up with a PCN, but all PCN's need a DCN.

10.4.2 PREPARING A PCN

Cost Engineering is responsible to analyze the PCN with respect to the time and resources required. A cost engineer will verify that the scope covered in the PCN is in fact outside the original scope of the project. An estimate of direct and indirect costs shall be prepared.

All disciplines on the project team will be consulted and any effect on their workload incorporated into the PCN. The PCN must also cover the cost of the preparation of the PCN, including related services.

10.4.3 APPROVAL AND RECORDING OF PCN'S

After the PCN is fully priced and its effect on the project fully analyzed, estimating group will have an internal review with concerned personnel involved in the PCN, the project engineer and the project engineering manager. The PCN then will be submitted to the project manager for his approval, and through him, the Client's approval. All parties concerned in a particular PCN must be notified upon approval (or rejection) of the PCN by the Client. The estimated cost of the approved PCN will be appropriately recorded and incorporated into the estimate, budget for control purposes.

Fig.41 shows the Impact to incorporate project changes

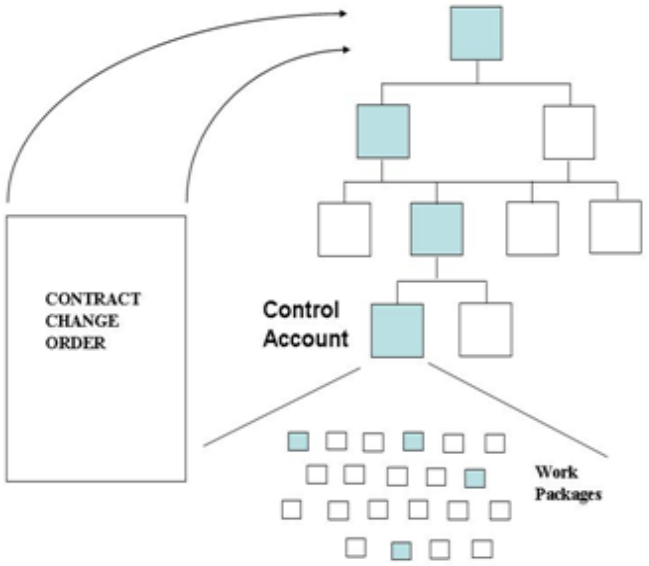


Fig.41 "Impact" to Incorporate Project Changes

10.5 RISK MANAGEMENT CONTROL

Risk management control starts with the implementation of any risk probability reduction or risk impact minimization activities.

10.5.1 RISK AVOIDANCE APPROACH IMPLEMENTATION

Various risk probability reduction approaches will be suggested for actual implementation, based on the previously defined risk avoidance approach and in accordance with the project plan.

10.5.2 RISK REPORTS AND REVIEWS

Risk reports are to be developed periodically during project performance based on a risk database containing information for all project's active risk issues. The risk reports must contain all pertinent data about each risk being managed. They become an agenda item for both functional-level and project-level reviews where risk issues status will be discussed. Much of the report will be static with certain areas requiring updates by the respective,

responsible project team member who will present relevant risk status reports. The project manager (risk manager) will present consolidated risk status as part of the client's progress reviews. Subcontractors will report risk status in the same manner as the functional organizations.

10.5.3 IMPLEMENTATION OF RISK CONTINGENCY PLAN

The implementation of the given risk contingency plan is reported to the project manager (risk manager) for approval by the project team member responsible for a given risk issue.

10.5.4 RISK CONTINGENCY PLAN ACTIVITIES EVALUATION

An evaluation of the effectiveness of each risk contingency plan implemented is made on a periodic basis and reported. The individual responsible for the respective risk issue will periodically evaluate the effectiveness of any implemented risk contingency plan actions and report the degree of effectiveness in the risk report. The frequency of evaluation should match the reporting frequency. The project manager (risk manager for larger project) will periodically review these evaluation reports for consistency of implementation. In the risk report, the status of risk contingency plan activities should summarize those activities initiated to minimize the impact of the risks that have materialized.

10.5.5 REDEFINITION OF CONTINGENCY PLANS

The respective project leader will implement the process of redefining the contingency plan approach for a risk issue should this be required.

Fig. 42 illustrates the Risk Management Control process:

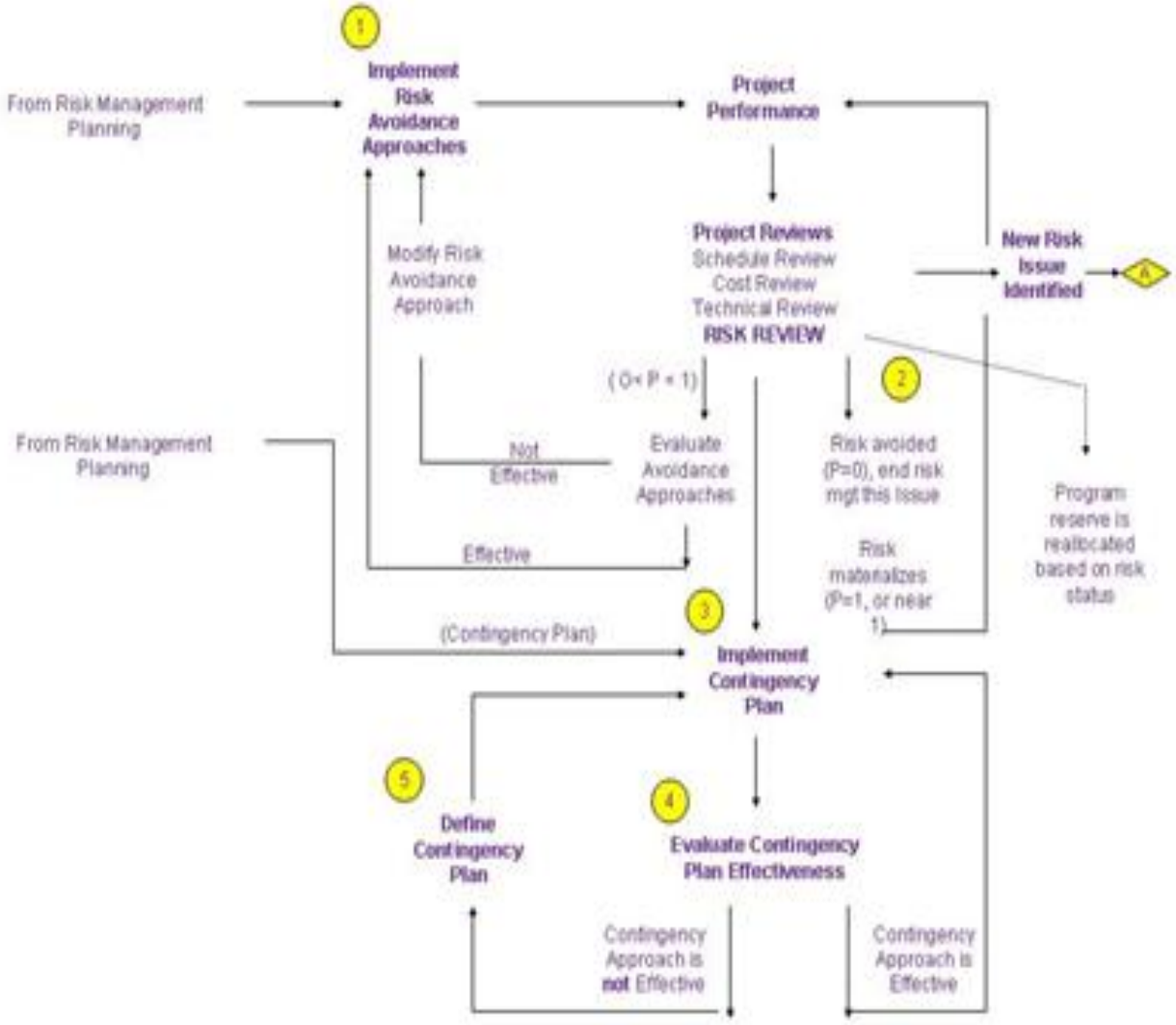


Fig. 42 Risk Management Control

10.6 MANPOWER FORECASTING, LEVELLING (MFL) AND CONTROL

The purpose of MFL is to identify present and future requirements of project personnel for project services cost control and staff allocation. It is to identify the manpower needs for the project as well as to revise the manpower needs, variations and forecasts. MFL benefits include improved staffing options for project, improved project manpower planning and allocation, improved inter departmental communication, better management of human resources information, reduction in risk to project schedules and reduction in costs related to human resources activities.

10.6.1 DATA COLLECTION AND PROCESSING

Requirements and assignments are originated from the supervisory level closest to the work to be performed, i.e., by the project manager and project discipline or area managers. The requirements, in the form of specific percentage of skills, are quantified monthly. To validate these needs, the project must plan the work in terms of effort, i.e., man-hours to go

(or budgeted) for each activity plus the duration and logical relationship of the various activities. The inputs will be entered into the computerized system for processing purposes and preliminary computer reports are produced approximately one week prior to month end and distributed to project manager and disciplined managers and corrections are made in the areas of re-assignments, leave of absence, holidays, vacations, etc

10.6.2 UTILIZATION OF REPORTS

The MFL report is produced on line for project managers and project discipline managers before the month end, and lists all manpower assignments and requirements by project. Inputs for the following month are entered interactively for the project, modifying the project's database records. The report also includes over-assignments and under-assignments and is used for interdepartmental loans or transfers of personnel.

10.6.3 MANPOWER LEVELLING & CONTROL

In the project, request for specific individuals which cause an over-assignment are negotiated by the chief of discipline with the project manager. Over assignment can be eliminated by rescheduling of tasks (if possible within project constraints) or by staffing with alternate individuals with similar skills. When the conflict is of short duration, over assignment can be acceptable if additional hours are authorized by both the project and chief of discipline.

11. PROJECT CLOSING

Closing a project involves completing all activities required to accomplish successfully all deliverables. It deals with collection of project records, validation of project success or failure, lessons learned, and the archival of project information for historical information. There are two documentation-related outputs to be concerned about: the closing of the project procedure and the contract closure procedure.

The contract closure procedure deals with closing out any contract-related activities on the project, including resolution of any open items. These include product verification that all work on the project (as related to contract) done as defined (correct and to stakeholders' satisfaction), and administrative closure, which includes updating archived and historical contract documentation on the project for future project use.

11.1 PROJECT FILES AND CONTRACT FILE

Project files and contract file are created in the closing of a project. Project files are created in the close project process; the contract file is created in the Contract Closure process. Project files are any project documents that record what happened, what decisions were made, and what changes were approved. Financial records, legal documents, etc. are part of this file. The contract file created in the procurement process (if procurement is done) contains documentation associated with the contract, approved changes, and formal acceptance.

11.2 CLOSING THE PROJECT

This is the point at which the customer agrees to accept the product of the project. The customer or sponsor is basically signing off, indicating satisfaction with the work and other activities of the project. This closure basically says that the work (product) of the project and the project are complete. After closing the Project, anything else will be warranty work or new work.

11.3 LESSONS LEARNED

Lessons can come along before the end of a project, as an opportunity that allows the team to learn from something and improve on the project as they are completing it. If they come at the end of the project, the closing of the project procedures come into play.

11.4 SEQUENCE FOR CLOSURE

The general order of the closing sequence of items for a project, would be as follows (Although it can vary, in reality, from company to company):

- Complete any close project activities.
- Deliver any required reports associated with closure.
- Close out any contract with outside vendors.
- Complete the archiving of any project files.
- Release resources for other projects.

Fig.43 shows the project closing process and contract closure interaction process.

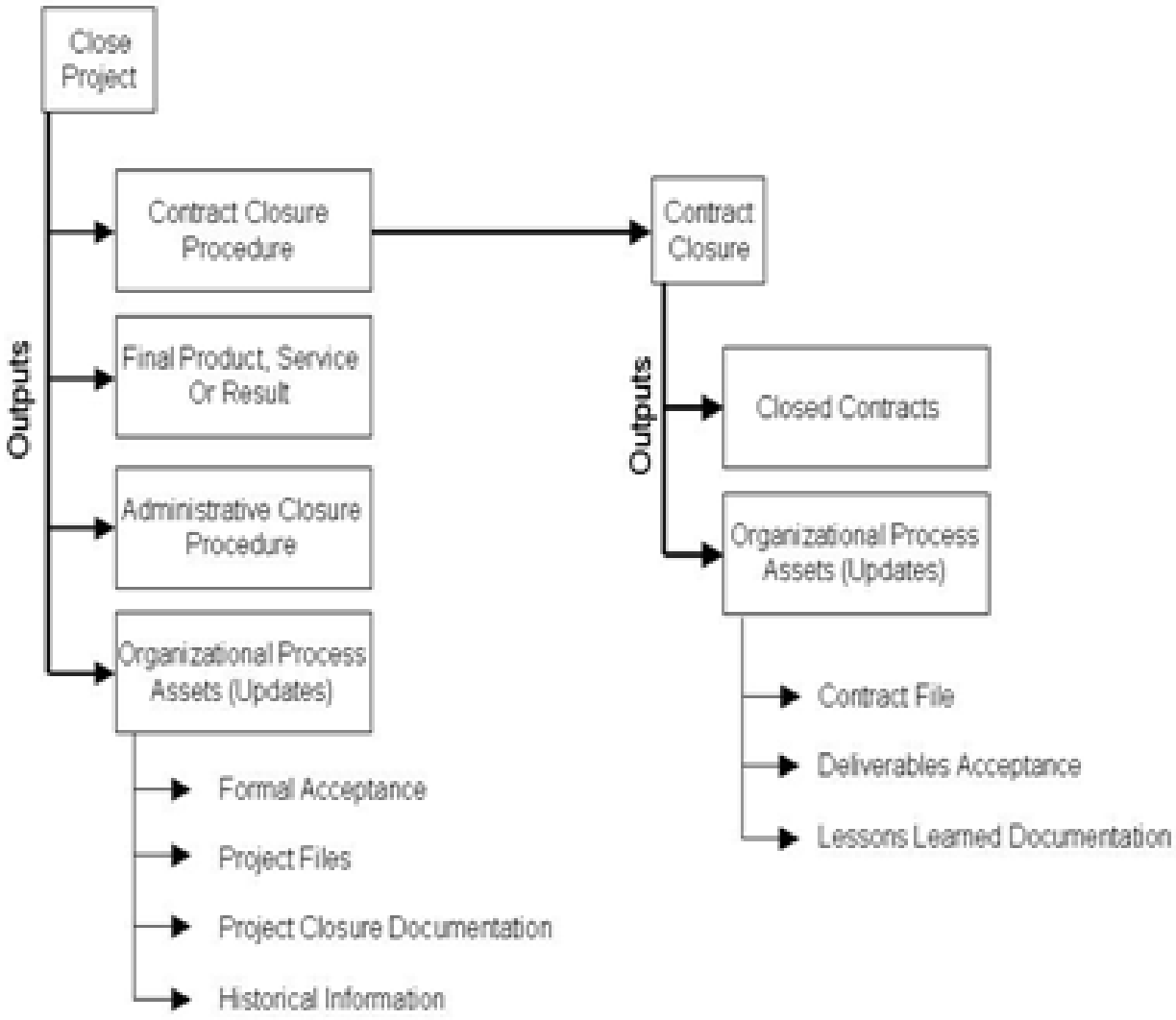


Fig. 43 Close Project and Contract Closure Interaction

12. PROJECT SUPERVISION

The project plan is a framework for project supervision. It provides the road map and the measurement standards for project execution and control. It defines how the project will be executed, monitored, controlled and closed. A good project plan is pivotal to ensure effective supervision on project activities.

Project supervision helps to follow up milestones, checkpoint phases as well as to discover new facts and requirements, resolution of open and unexpected issues typically happen during project execution. The main purpose of project supervision is to help ensure that projects achieve their objectives. In general, it is anticipated that a significant and persistent increase in the level of supervision should lead to an increased project performance.

Project supervision includes project implementation, integrated cost/schedule controls, subcontractor management, site staffing, quality management and functional oversight of project performance through contract completion.

Supervision tasks will include but not limited to the following:

- Ensure that the construction methods proposed by the contractor for carrying out the works are satisfactory.
- Inspection of contractor's construction equipment, results of material and soil tests, safety of the works, property and personnel.
- Establish efficient procedures for verifying contractor performance and reporting progress and problems in a timely manner, including quality control reports, quantity survey records, requests for variation or change orders, and contractor's claims and invoices.
- Undertake project performance monitoring and evaluation in accordance with the project's performance management approach and reporting up to project completion.
- Prepare and issue reports such as an inception report, a brief monthly progress report, a detailed quarterly report, and a detailed project completion report.
- Review and verify any proposed change orders to be generated by the contractors and make recommendations to the Engineer (Designer)
- Check that "as-built" drawing is prepared by the contractors for all works as reflection of construction processes.
- Carry out duties related to environmental mitigation, with particular reference to the technical requirements of sound environmental standards.
- Prepare reports such as draft completion report, final project completion report, etc.
- Process interim and final payments of the contractors.

12.1 PROJECT IMPLEMENTATION

The process required to put into action all planned activities. It includes monitoring where steps are taken to ensure that activities are implemented as planned. The objective of project implementation is to optimize the mobilization, utilization and control of resources and project operations. Project implementation begins with the contract award and pertains to the conduct of project management tasks including reviews, technical support, approval of deliverables, project performance assessment, payments including final payment. Project implementation ends when the contract involvement is finished and funds have been disbursed.

Management of the project implementation is one of the most time-consuming activities of the project team. A good project definition in the early stages of the project makes this task easier and much more effective and efficient. Good communication between the project manager, project team members and the contractor is also very important.

While the Project Manager is directly responsible for the management of the project, the key team members, e.g., Engineering Manager, Procurement Manager and Construction Manager in an EPC project, are responsible for putting implementation mechanisms in place for ensuring that funds are spent for the purposes intended and approved, based on clear objectives and measurable anticipated outputs. This responsibility is exercised through an appropriate management structure and through monitoring, which may, on smaller projects, be limited to the review of quarterly progress and financial reports. It may also include site visits, engagement of outside monitors, evaluation, audit and corrective actions where necessary. Use of outside monitors can be beneficial in case of large projects, technically complex project or high monitoring workload requirements. During this stage, key team member is responsible for:

- Assuming monitoring role and responsibilities.
- Developing required Statement of Work (SOW) and requisition material for contracted support as necessary.
- Ensuring adequate internal monitoring by analyzing progress reports; conducting field missions; following-up on recommendations.
- Preparing and/or updating internal reports. Ensuring that necessary data is collected to report on project results.
- Identifying major problem to the project manager and recommending measures to redress.

Fig. 44 represents the typical, generic flow of the various steps carried out during project implementation.

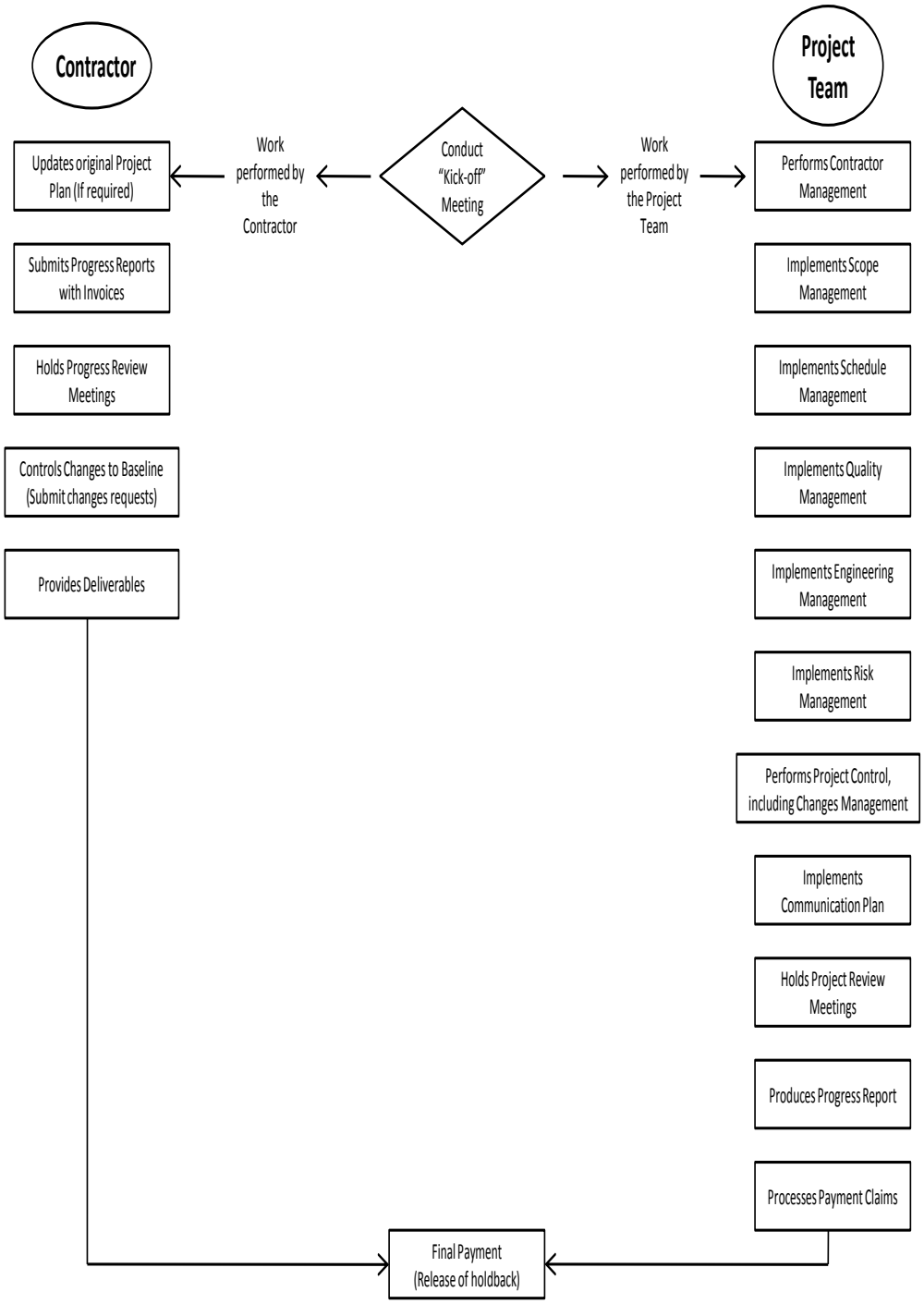


Fig. 44 Project Implement Activities

12.2 INTEGRATED COST & SCHEDULE CONTROL

The Earned Value Management (EVM) technique is used for effective management of cost and schedule. It is the most comprehensive and effective method of developing integrated cost and schedule plan and managing the true cost and schedule status of a project. Good project supervision requires an effective EVM system where project status reports reflect the budget and schedule status realistically and objectively from very early in a project and are practical and effective tools for forecasting future performance and completion costs after sufficient reporting periods have established performance trends.

12.3 SUBCONTRACTOR MANAGEMENT

Management of subcontractors' activities is critical in any project's progress and success. Too often project objectives are not accomplished on time and within prescribed budget. Many times, it is because of unsuccessful management of what subcontractors are to deliver, i.e., their abilities to deliver the materials or services within their budgets and time commitments. Hence, the monitoring and control of subcontractor's contract performance plays an important role in project supervision. Subcontractor management covers activities beginning with the proposal, pre-award stage, through subcontract planning and control to completion.

The objectives of effective subcontractor management are to ensure that subcontractors use appropriate procedures for the planning, control, and status reporting of the integrated scope, cost, and schedule parameters of their contract commitments consistent with prime contract requirements and subcontract efforts are adequately identified and performances accurately measured and reported on a regular and required basis for quick integration into the prime contract.

The subcontractor management process involves the planning, control and reporting of its milestones achievement, e.g., milestones completion during the design, procurement, construction activities. It is also important that subcontractors price the items of work to the same conditions of contract and specification in the main contract.

Fig. 45 shows the procedure schematic for subcontractor management.

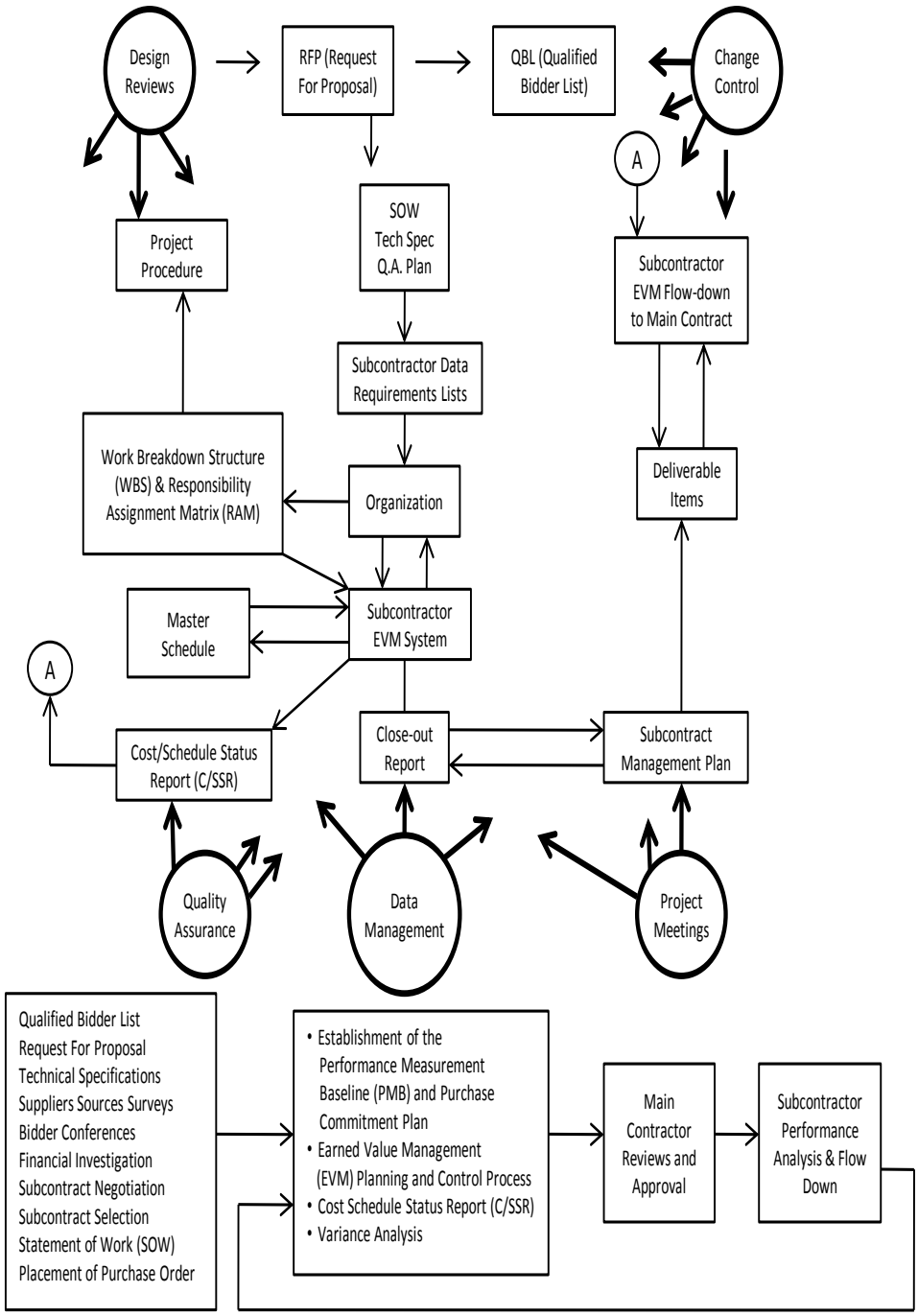


Fig. 45 Subcontractor Management in Project Management

12.4 SITE STAFFING

Site staff includes workers, foremen, engineers, contract managers, safety officers, etc. A site staffing management plan must be supervised and monitored, describing when and how site manpower requirements will be met. The plan must be updated continually during project implementation and execution to direct on-going staffing acquisition and development actions. It describes necessary working time frames for required staff, including when acquisition activities such as recruiting should start and when staff are released from the project site. Project supervision involves identifying and scheduling future work needs so that the most efficient use is made of the resources available. Long-range resource requirements for general planning and short-term resources for detailed planning must be determined in order to establish which resources will be needed, when they must be on site, and the quantities required. Arrangements must be made for their timely arrival with regular follow-up actions taken to ensure that promised delivery dates are kept.

In addition, requirements such as training needs, recognition and rewards for staff as well as safety measures to protect staff from safety hazards are included in the site staffing management plan.

12.5 CLIENT-FOCUSED QUALITY MANAGEMENT

Client-focused quality management ensures the final project products delivered conform to client's requirement and meet their expectation and needs. This process, therefore, fully supports the objectives of project supervision. Client's needs are technical performance parameters, delivery on schedule and at acceptable cost so that the products delivered can solve their problem. Client-focused quality management builds a good relationship with the customers based on trust by meeting the following client's expectations:

- Deliveries will meet the Client's needs, delivered on time or earlier, according to the agreed- to prices, demonstrated appropriate levels of reliability and safety.
- Responsive, listen to feedback from the Client and provide an appropriate level of support.
- Negotiate reasonable engineering change costs for the products.
- Take steps to correct and eliminate, as soon as possible, the cause of problems indentified.

12.6 FUNCTIONAL OVERSIGHT OF PROJECT PERFORMANCE THROUGH CONTRACT COMPLETION

Project supervision involves technical expertise which resides in the functional areas of the organization. The success of a project is shared among the project manager and all the participating functional managers. Project managers are expected to focus on the management of project deliverables whereas management of the assigned resources on a project has become the domain of the functional managers. The functional manager has the responsibility to define how project tasks will be done, who will perform the work and the

technical criteria associated with the task, i.e., how well the functional inputs been integrated into the project. He also has the responsibility to provide sufficient and qualified resources to perform project activities and accomplish the objectives within the project constraints. Appropriate allocation of assigned resources to performed work activities impact project deliverables. Functional staff possess outstanding technical skills, work well by themselves and often resent supervision. Project supervision, on the other hand, provides the project manager with mechanism to measure project performance, forecast trends and prepare appropriate reports through contract completion. In most cases, the information for project reports must be obtained from a variety of functional managers, and their inputs must be reliable and accurate. Consequently, effective project supervision requires close functional oversight of project performance through contract completion.

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