Contents

Chapter 1 (Introduction)

- **A project** is a temporary endeavor undertaken to create a unique product, service, or result.
- **Project management** is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements. Project management is accomplished through the appropriate application and integration of the project management processes identified for the project

Project Initiation Context: Organizational leaders initiate projects in response to factors acting upon their organizations. There are four fundamental categories for these factors, which illustrate the context of a project

- ❖ Meet regulatory, legal, or social requirements;
- ❖ Implement or change business or technological strategies
- ❖ Satisfy stakeholder requests or needs;
- ❖ Create, improve, or fix products, processes, or services.

- **Program** is defined as a group of related projects, subsidiary programs, and program activities managed in a coordinated manner to obtain benefits not available from managing them individually. Programs are not large projects. A very large project may be referred to as a megaproject. As a guideline, megaprojects cost US$1billion or more, affect 1 million or more people, and run for years.

- **Program** and **project** management focus on doing programs and projects the "**right" way**. And **Portfolio** management focuses on doing the "**right**" programs and projects

- **Program** management is defined as the application of knowledge, skills, and principles to a program to achieve the program objectives and to obtain benefits and control not available by managing program components individually
- **Portfolio** is defined as projects, programs, subsidiary portfolios, and operations managed as a group to achieve strategic objectives. Portfolio management is defined as the centralized management of one or more portfolios to achieve strategic objectives. The programs or projects of the portfolio may not necessarily be interdependent or directly related.
- **Operations management** is an area that is **outside the scope** of formal project management which is concerned with the **ongoing** production of goods and/or services. However, operations & scope might intersect at some points

Organizational Project Management (OPM) is defined as a framework in which portfolio, program, and project management are integrated with organizational enablers in order to achieve strategic objectives. The purpose of OPM is to ensure that the organization undertakes **the right projects** and allocates critical resources appropriately and ensure that all levels in the organization understand the strategic vision.

Project life cycle is the series of phases that a project passes through from its start to its completion. It provides the basic framework for managing the project. The phases may be **sequential**, **iterative**, or **overlapping**

Project life cycles can be **predictive** or **adaptive,** within a project life cycle, there are generally one or more phases that are associated with the development of the product, service, or result. These are called a **development life cycle** (they can be **predictive**, **iterative**, **incremental**, **adaptive**, or **a hybrid model**).

- **Predictive** life cycle (**Waterfall**): the project scope, time, and cost are determined in the early phases of the life
- **Iterative** life cycle: project scope is generally determined early in the project life cycle, but time and cost estimates are routinely modified
- **Incremental** life cycle deliverable is produced through a series of iterations that successively add functionality within a predetermined time frame and it's considered complete only after the final iteration
- **Adaptive** life cycles are agile, iterative, or incremental. The detailed scope is defined and approved before the start of an iteration. Adaptive life cycles are also referred to as **agile** or **change-driven** life cycles
- **Hybrid** life cycle is a combination of a predictive and an adaptive life cycle. Those elements of the project that are well known or have fixed requirements follow a predictive development life cycle, and those elements that are still evolving follow an adaptive development life cycle

Project life cycles are **independent** of product life cycles, which may be produced by a project. A product life cycle is the series of phases that represent the evolution of a product, from concept through delivery, growth, maturity, and to retirement.

Project Phase: Collection of logically related project activities that culminates in the completion of one or more deliverables. The phases in a life cycle can be described by a variety of attributes

Phase gate: is held at the end of a phase. The project's performance and progress are compared to project and business documents. Also Called (phase review, stage gate, **kill point**, and phase entrance or phase exit)

PROJECT MANAGEMENT PROCESSES

Processes used once or at predefined points in the project: (Develop Project Charter, Develop Project Management Plan, Close Project/Phase, Plan Scope Management, Collect Requirements, Create WBS, Plan Schedule Management, Plan Cost Management, Determine Budget, Plan Quality Management, Plan Resource Management, Plan Risk Management, Plan Procurement Management)

Processes that are performed periodically as needed: (Validate Scope, Estimate Costs, Estimate Activity Resources, Acquire Resources, Plan Communication Management, Conduct Procurement, Identify Stakeholders, Plan Stakeholder Management)

Processes that are performed continuously throughout the project: (All other remaining process such as define activities)

Project Management is divided into **5 Process Groups** (Initiating, Planning, Executing, Monitoring & Controlling and Closing Process Group)

Project Management Divided into **10 Knowledge Areas** (Integration, Scope, Schedule, Cost, Quality, Resource, Communication, Risk, Procurement and Stakeholder Management)

Project data are regularly collected and analyzed throughout the project life cycle. The following definitions identify key terminology regarding project data and information

Work performance data: The raw observations and measurements identified during activities performed to carry out the project work, such as (Percent of finished work, Start and finish dates, number of change requests, actual costs and durations). Project data are usually **recorded** in a Project Management Information System (**PMIS**)

Work performance information: Performance data collected from various controlling processes, analyzed in context and integrated based on relationships across areas, such as (**status** of deliverables, implementation **status** for change requests, and **forecast** estimates to complete)

Work performance reports. The physical or electronic representation of work performance information compiled in project documents, which is intended to generate decisions or raise issues, actions, or awareness, such as (status **reports**, memos, justifications, information notes, electronic dashboards, recommendations, and updates)

Knowledge Areas	Project Management Process Groups				
	Initiating Process Group	**Planning Process Group**	**Executing Process Group**	**Monitoring and Controlling Process Group**	**Closing Process Group**
4. Project Integration Management	4.1 Develop Project Charter	4.2 Develop Project Management Plan	4.3 Direct and Manage Project Work 4.4 Manage Project Knowledge	4.5 Monitor and Control Project Work 4.6 Perform Integrated Change Control	4.7 Close Project or Phase
5. Project Scope Management		5.1 Plan Scope Management 5.2 Collect Requirements 5.3 Define Scope 5.4 Create WBS		5.5 Validate Scope 5.6 Control Scope	
6. Project Schedule Management		6.1 Plan Schedule Management 6.2 Define Activities 6.3 Sequence Activities 6.4 Estimate Activity Durations 6.5 Develop Schedule		6.6 Control Schedule	
7. Project Cost Management		7.1 Plan Cost Management 7.2 Estimate Costs 7.3 Determine Budget		7.4 Control Costs	
8. Project Quality Management		8.1 Plan Quality Management	8.2 Manage Quality	8.3 Control Quality	
9. Project Resource Management		9.1 Plan Resource Management 9.2 Estimate Activity Resources	9.3 Acquire Resources 9.4 Develop Team 9.5 Manage Team	9.6 Control Resources	
10. Project Communications Management		10.1 Plan Communications Management	10.2 Manage Communications	10.3 Monitor Communications	
11. Project Risk Management		11.1 Plan Risk Management 11.2 Identify Risks 11.3 Perform Qualitative Risk Analysis 11.4 Perform Quantitative Risk Analysis 11.5 Plan Risk Responses	11.6 Implement Risk Responses	11.7 Monitor Risks	
12. Project Procurement Management		12.1 Plan Procurement Management	12.2 Conduct Procurements	12.3 Control Procurements	
13. Project Stakeholder Management	13.1 Identify Stakeholders	13.2 Plan Stakeholder Engagement	13.3 Manage Stakeholder Engagement	13.4 Monitor Stakeholder Engagement	

Methodology is a system of practices, techniques, procedures, and rules used by those who work in a discipline which project manager apply in their management. (PMBOK is **NOT** a methodology, but a recommended reference for tailoring). **Tailoring** is necessary because each project is **unique.**

Project Management Business Documents

1- **Project business case**
2- **Project benefits management plan**

Project **sponsor** is generally **accountable** for the development and maintenance of the project **business case** document. The **project manager** is responsible for providing **recommendations and oversight**

Project managers should appropriately **tailor** the noted project management documents, In some organizations, the business case and benefits management plan are **maintained** at the **program level**

Business case is a documented economic feasibility study used to establish the validity of the benefits of a selected component lacking sufficient definition and that is used as a basis for the authorization of further project management activities it lists the objectives and reasons for project initiation.

It helps measure the **project success** at the **end of the project** against the project objectives The business case may be used **before the project initiation** and may result in a **go/no-go** decision for the project.

A business case may include (Business Needs, Analysis of the situation (Required, Desired, Optional), Evaluation)

Project benefits management plan is the document that describes how and when the benefits of the project will be delivered, and describes the mechanisms that should be in place to measure those benefits. Development and maintenance of the project benefits management plan is an **iterative** activity

Development of the benefits management plan begins early in the project life cycle with the definition of the target benefits to be realized and it may include (Target benefits, Strategic alignment, Timeframe for realizing benefits, benefits owner, metrics, assumptions, risks)

Developing the benefits management plan **makes use** of the data and information documented in the **business case** and needs assessment.
It is possible for a project to be successful from a scope/schedule/budget viewpoint, and to be unsuccessful from a business viewpoint. This can occur when there is a change in the business needs or the market environment

Chapter 2 (Environment in Which Projects Operate)

Projects exist and operate in environments that may have an influence on them. These influences can have a **favorable** or **unfavorable** impact on the project. Two major categories of influences are enterprise environmental factors (**EEFs**) and organizational process assets (**OPAs**).

EEFs originate from the environment **outside** of the project and often outside of the enterprise. EEFs may have an impact at the organizational, portfolio, program, or project level. EEFs refers to conditions **not** under the control of the project team and it could Internal and External.

Examples of internal EEF's

- **Organizational culture, structure, and governance**
- Geographic distribution of facilities and resources
- Infrastructure
- Information technology software
- Resource availability**.**
- Employee capability

Examples of External EEF's

- Marketplace conditions
- Social and cultural influences and issues
- Legal restrictions
- **Commercial databases**
- Academic research
- Government or industry standards
- Financial considerations
- Physical environmental elements

OPAs are internal to the organization. These may arise from the organization itself, a portfolio, a program, another project, or a combination of these. Organizational process assets (OPAs) are the **plans**, **processes**, **policies**, **procedures**, and **knowledge bases.**

Processes, policies, and procedures **are not updated** as part of the project work and usually established by the project management office (**PMO**). However, these can be updated only by following the appropriate organizational policies associated with updating processes.

Organizational knowledge bases are **updated throughout the project** with project information

Examples of OPA's (Processes, Policies and Procedures)

- **Guidelines** and criteria for tailoring
- Specific organizational **standards** such as **policies**
- Product and project life cycles, and methods and procedures
- Issue and defect management **procedures**
- Preapproved supplier lists and other contractual **agreements**.
- Change control **procedures**
- **Traceability matrices**
- Financial controls **procedures**
- **Templates**
- Resource availability

Examples of OPA's (Organizational Knowledge Repositories)

- Configuration management
- Issue and defect management data
- Financial data repositories
- repositories for metrics
- **Historical information and lessons learned**
- Project files from previous projects

A system is a collection of various components that together can produce results not obtainable by the individual components alone. A component is an identifiable element within the project or organization that provides a particular function or group of related functions

Systems are Dynamic, can be optimized, but can't be optimized with components at same time, Systems are **nonlinear** in responsiveness. Systems are typically the **responsibility** of an organization's management

Governance refers to organizational or structural arrangements at all levels of an organization designed to determine and influence the behavior of the organization's members

Project governance refers to the framework, functions, and processes that guide project management activities in order to create a unique product

A project management office (PMO) is an organizational structure that standardizes the project-related governance processes and facilitates the sharing of resources, methodologies, tools, and techniques.

Supportive PMOs provide a **consultative** role to projects by supplying templates, best practices, training, access to information, and lessons learned from other projects. This type of PMO serves as a project repository. The degree of control provided by the PMO is **low**.

Controlling PMOs provide **support** and require **compliance** through various means. The degree of control provided by the PMO is **moderate.** Compliance may include (Adoption of project management frameworks or methodologies, use of specific templates, forms, and tools, conformance to governance frameworks)

Directive PMOs **take control** of the projects by **directly managing** the projects. Project managers are assigned by and **report** to the PMO. The degree of control provided by the PMO is **high**

PMO is the natural liaison between the organization's portfolios, programs, projects, and the organizational measurement systems

A **primary** function of a PMO is to support project managers

Organizational Structure Type	Project Characteristics					
	Work Groups Arranged by:	Project Manager's Authority	Project Manager's Role	Resource Availability	Who Manages the Project Budget?	Project Management Administrative Staff
Organic or Simple	Flexible; people working side-by-side	Little or none	Part-time; may or may not be a designated job role like coordinator	Little or none	Owner or operator	Little or none
Functional (centralized)	Job being done (e.g., engineering, manufacturing)	Little or none	Part-time; may or may not be a designated job role like coordinator	Little or none	Functional manager	Part-time
Multi-divisional (may replicate functions for each division with little centralization)	One of: product; production processes; portfolio; program; geographic region; customer type	Little or none	Part-time; may or may not be a designated job role like coordinator	Little or none	Functional manager	Part-time
Matrix – strong	By job function, with project manager as a function	Moderate to high	Full-time designated job role	Moderate to high	Project manager	Full-time
Matrix – weak	Job function	Low	Part-time; done as part of another job and not a designated job role like coordinator	Low	Functional manager	Part-time
Matrix – balanced	Job function	Low to moderate	Part-time; embedded in the functions as a skill and may not be a designated job role like coordinator	Low to moderate	Mixed	Part-time
Project-oriented (composite, hybrid)	Project	High to almost total	Full-time designated job role	High to almost total	Project manager	Full-time
Virtual	Network structure with nodes at points of contact with other people	Low to moderate	Full-time or part-time	Low to moderate	Mixed	Could be full-time or part-time
Hybrid	Mix of other types	Mixed	Mixed	Mixed	Mixed	Mixed
PMO*	Mix of other types	High to almost total	Full-time designated job role	High to almost total	Project manager	Full-time

Chapter 4 (Project Integration Management)

Project Integration Management includes the processes and activities to identify, define, combine, unify, and coordinate the various processes and project management activities within the Project Management Process

Iterative and agile approaches promote the engagement of team members as local domain experts in integration management. The team members determine how plans and components should integrate. team. The project manager's focus is on building a collaborative decision-making environment and ensuring the team has the ability to respond to changes.

Develop Project Charter (Initiating Process Group)

Develop Project Charter is the process of developing a document that **formally authorizes the existence of a project** and provides the project manager with the authority to **apply organizational resources** to project activities.

Key benefits of this process are that it provides a direct link between the project and the strategic objectives of the organization, creates a formal record of the project, and shows the organizational commitment to the project

- This process is performed **once** or at predefined points in the project
- Project charter may still be used to establish internal agreements within an organization to ensure proper delivery under the contract
- Project manager is identified and **assigned** as **early** in the project as is feasible, preferably while the project charter is being developed and **always prior to the start of planning**
- The project charter can be **developed** by the sponsor or the project manager in collaboration with the initiating entity.
- Project charter provides the project manager with the authority to plan, execute, and control the project.
- Projects are **initiated** by an entity external to the project such as a sponsor, program, or project management office (PMO)
- Project are initiated due to internal business needs or external influences
- Project charter is **not considered to be a contract**

Develop Project Charter Inputs:

1- Business Documents (Business Case & benefits management plan)

- Business Case is most commonly used to create the project charter.
- Business need and the cost benefit analysis are contained in the business case to justify and establish boundaries for the project
- Business case is created as a result of (Market demand, Organizational need, Customer request, Technological advance, legal requirement, Ecological impacts and Social need)
- The project manager **does not update or modify the business documents** since they are not project documents; however, the project manager may **make recommendations**.

2- Agreements

- It may take the form of contracts, memorandums of understanding (MOUs), service level agreements (SLA), letters of agreement, letters of intent, verbal agreements, email, or other written agreements
- Typically, a contract is used when a project is being performed for an external customer

3- Enterprise Environmental Factors

4- Organizational Process Assets

Develop Project Charter Tools and Techniques:

1- Expert Judgment

- Provided by any group or person with specialized education, knowledge, skill, experience, or training.
- Expertise can be from (Organizational strategy, Benefits management, Technical knowledge of the industry, Duration and budget estimation, Risk identification)

2- Data Gathering

- **Brainstorming:** technique is used to identify a **list of ideas** in a **short** period of time. It is conducted in a group environment and is led by a **facilitator**. Brainstorming comprises two parts: **idea generation** and **analysis**. Brainstorming can be used to gather data and solutions or ideas from stakeholders, subject matter experts (SME), and team members when developing the project charter.
- **Focus Groups:** bring together stakeholders and subject matter experts to learn about the perceived project risk, **success criteria**, and other topics in a more conversational way than a one-on-one interview. A trained **moderator** guides through an interactive discussion.
- **Interviews:** used to obtain information on **high-level requirements**, assumptions or **constraints**, approval criteria, and other information from stakeholders by **talking directly to them.**

3- Interpersonal and Team Skills

- **Conflict Management:** Conflict management can be used to help bring stakeholders into **alignment** on the objectives, success criteria, high-level requirements, project description, summary milestones, and other elements of the charter.
- **Facilitation:** ability to effectively guide a group event to a successful decision, solution, or conclusion. A **facilitator** ensures that there is **effective participation**, that participants achieve a **mutual understanding**, that all contributions are considered, that conclusions or results have full buy-in according to the decision process established for the project, and that the actions and agreements achieved are appropriately dealt with afterward.
- **Meeting Management:** includes **preparing the agenda**, ensuring that a representative for **each key stakeholder group is invited**, and preparing and sending the follow-up minutes and actions.

4- Meetings

- Meetings are held with **key stakeholders** to identify the project objectives, success criteria, key deliverables, high-level requirements, summary milestones, and other summary information

Develop Project Charter Outputs:

1- Project Charter

- It documents high-level information on the project/product or result the projects intended to satisfy such
  - Project purpose
  - Objectives and success criteria
  - High-level requirements
  - Overall project risk
  - Milestone schedule
  - Preapproved financial resources
  - Key stakeholders list
  - Project Approval requirements
  - Project exit criteria
  - Assigned project manager, responsibility and authority
  - Name of sponsor or persons authorizing project charter

2- Assumption Log

- **High level** strategic and operational assumptions and constraints are normally identified in the **business case before** the project is **initiated** and will flow **into the project charter**.
- **Lower-level** activity and task assumptions are generated **throughout the project** such as defining technical specifications, estimates, the schedule, risks, etc.
- The assumption log is used to **record all assumptions and constraints** throughout the project life cycle.

Develop Project Management Plan (Planning Process Group)

Develop Project Management Plan is the process of defining, preparing, and coordinating all plan components and consolidating them into an integrated project management plan.
Key benefit of this process is the production of a **comprehensive document** that defines the basis of all project work and how the work will be performed

- This process is performed **once** or at predefined points in the project.
- Project management plan may be either summary level or detailed
- Project management plan should be **baselined (**Scope, time and cost). so that the project execution can be measured and **compared** to those references and performance can be managed
- Project management plan **may be updated as many times as necessary**. No formal process is required at that time. **But, once it is baselined**, it may only be **changed through the Perform Integrated Change Control process**

Develop Project Management Plan Inputs:

1- Project Charter

- Project team uses the project charter as a starting point for initial project planning
- Project charter should define the high-level information that will be elaborated.

2- Outputs from other processes

- Subsidiary plans and baselines that are an output from other planning processes are inputs to this process
- Changes to these documents may necessitate updates to the project management plan

3- Enterprise Environmental Factors

4- Organizational Process Assets

Develop Project Management Plan Tools & Techniques:

1- Expert Judgment

- individuals or groups with specialized knowledge of or training such as (Tailoring, develop additional components, determine resources and skill level, define Configuration Management, **prioritize work on the project and ensure resources are appropriately allocated**)

2- Data Gathering

- **Brain Storming:** Attendees include the project team members although other subject matter experts (SMEs) or stakeholders may also participate

- **Checklists:** May guide the project manager to develop the plan or may help to verify that all the required information is included in the project management plan
- **Focus Groups:** bring together stakeholders to discuss the project management approach and the integration of the different components of the project management plan
- **Interviews:** Interviews are used to obtain specific information from stakeholders to develop the project management plan or any component plan or project document

3- Interpersonal and Team Skills

- **Conflict Management**
- **Facilitation**
- **Meeting Management**

4- Meetings

- Meetings are used to discuss the project approach, determine how work will be executed to accomplish the project objectives, and establish the way the project will be monitored and controlled
- **kick-off meeting** is usually associated with the **end of planning** and the **start of executing**. Its purpose is to communicate the **objectives** of the project, gain the **commitment** of the team for the project, and explain the **roles and responsibilities** of each stakeholder
- For **small projects**, there is usually only one team that performs the planning and the execution. In this case, the kick-off occurs **shortly after initiation**, in the **Planning** Process Group, because the team is involved in planning
- For **large projects**, a project management team normally does the majority of the planning, and the remainder of the project team is brought on when the initial planning is complete, at the start of the development/implementation. In this instance, the kick-off meeting **takes place** with processes in the **Executing Process Group**
- **Multiphase** projects will typically include a kick-off meeting at the **beginning of each phase**

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<u>Develop Project Management Plan Outputs:</u>

1- Project Management Plan Which includes

Subsidiary management plans: (Scope Management plan, Requirements management plan, Schedule management plan, Cost management plan, Quality management plan, Resource management plan, Communications management plan, Risk management plan, Procurement management plan, Stakeholder engagement plan.)

Baselines

- **Scope Baseline**: approved version of a scope statement, work breakdown structure (WBS), and its associated WBS dictionary, which is used as a basis for comparison
- **Schedule Baseline**: The approved version of the schedule model that is used as a basis for comparison to the actual results.
- **Cost Baseline**: The approved version of the time-phased project budget that is used as a basis for comparison to the actual results.

Additional components

- **Change management plan**: Describes how the change requests throughout the project will be formally authorized and incorporated.

- **Configuration management plan**: Describes how the information about the items of the project (and which items) will be recorded and updated so that the product, service, or result of the project remains consistent and/or operative.

- **Performance measurement baseline**: An integrated scope-schedule-cost plan for the project work against which project execution is compared to measure and manage performance.

- **Project life cycle**: Describes the series of phases that a project passes through from its initiation to its closure.

- **Development approach**: Describes the product, service, or result development approach, such as predictive, iterative, agile, or a hybrid model.

- **Management reviews:** Identifies the points in the project when the project manager and relevant stakeholders will review the project progress to determine if performance is as expected, or if preventive or corrective actions are necessary.

- Project management plan is one of the primary documents used to manage the project, other project documents are also used. These other documents are not part of the project management plan; however, they are necessary to manage the project effectively

Direct and Manage Project Work (Executing Process Group)

Direct and Manage Project Work is the process of leading and performing the work defined in the project management plan and implementing approved changes to achieve the project's objectives
Key benefit of this process is that it provides overall management of the project work and deliverables, thus improving the probability of project success

- This process is performed throughout the project
- Direct and Manage Project Work involves executing the planned project activities to **complete project deliverables** and accomplish established **objectives** and **allocate available resources**.
- Project Manager and project team directs the performance of planned activities
- Direct and Manage Project Work also requires review of the impact of all project changes and the **implementation of approved changes**: corrective action, preventive action, and/or defect repair.
- Work Performance **data** is collected and communicated to the applicable process for analysis

Direct and Manage Project Work Inputs:

1- Project Management Plan

2- Project Documents

- **Change Log:** Contains the status of all change requests.
- **Lessons learned register:** Used to improve the performance of the project and to **avoid repeating mistakes**. The register helps identify where to set **rules** or guidelines so the team's actions are aligned.
- **Milestone list:** Shows the scheduled dates for specific milestones
- **Project communications:** Include performance reports, deliverable status
- **Project schedule:** Includes at least the list of work activities, their durations, resources, and planned start and finish dates.
- **Requirements traceability matrix:** Links **product requirements** to the **deliverables** that satisfy them and helps to focus on the final outcomes.
- **Risk register:** Provides information on **threats** and **opportunities** that may impact project execution.
- **Risk report:** provides information on sources of overall project risk along with summary information on identified individual project risks.

3- Approved Changed Requests

- Approved change requests are an output of the Perform Integrated Change Control process
- Include requests reviewed and approved for implementation by the project manager or by the change control board (CCB).

- The approved change request may be a corrective action, a preventive action, or a defect repair.
- Approved change requests are scheduled and implemented by the project team and can impact any area of the project or project management plan.
- The approved change requests can also modify the formally controlled project management plan components or project documents.

4- Enterprise Environmental Factors

5- Organizational Process Assets

Direct and Manage Project Work Tools and Techniques:

1- Expert Judgment

2- Project Management Information System (PMIS)

- PMIS provides access to information technology (IT) software tools, such as scheduling software, work authorization systems, configuration management systems, information collection and distribution systems.
- Automated gathering and reporting on key performance indicators (**KPI**) can **be part of this system**.

3- Meetings

- Type of meetings (Kick-off, technical, sprint, iteration planning, Scrum daily standups, steering group, problem solving, progress update and retrospective meetings)

Direct and Manage Project Work Outputs:

1- Deliverables

- A deliverable is any unique and verifiable product, result, or capability to perform a service that is required to be produced to complete a process, phase, or project
- Deliverables are typically the outcomes of the project and can include components of the project management plan
- Change control should be applied once the first version of a deliverable has been completed
- The control of multiple deliverable versions is supported by **configuration management** tools.

2- Work Performance Data

- Data are often viewed as the **lowest level** of detail from which information is derived by other processes.
- Example of Work Performance Data is (**KPI**, actual start and finish dates, deliverable status, technical performance, story points completed)

3- Issue Log

- Project document where all the issues are recorded and tracked. Data on issues may include
- Issue log is created for the first time as an output of this process
- Issue log is updated as a result of the monitoring and control activities throughout the project's life cycle.

4- Change Requests

- Any project stakeholder may request a change
- Change requests can be initiated from inside or outside the project and they can be optional or legally/contractually mandated
- Change Requests can be (Corrective, Preventive, Defect repair (modify nonconforming product), Updates)

5- Project Management Plans Updates

6- Project Document Updates

- Activity list, Assumption log, Lessons learned register, Requirements documentation, Risk register, Stakeholder register

7- Organizational Process Assets Updates

Mange Project Knowledge (Executing Process Group)

Manage Project Knowledge is the process of using **existing** knowledge and **creating** new knowledge to achieve the project's objectives and contribute to organizational learning

Key benefits of this process are that prior organizational knowledge is leveraged to produce or improve the project outcomes, and knowledge created by the project is available to support organizational operations and future projects or phases

- This process is performed throughout the project
- Knowledge can be explicit or tacit
- Explicit knowledge can be readily codified using words, pictures, and numbers.
- Tacit knowledge is personal and difficult to express, like beliefs, insights, experience, and "know-how"
- Managing knowledge is **not just** documenting it or to obtain lessons learned only for future projects
- Explicit knowledge can be easily shared, however tacit knowledge has context build so it's hard to codify and normally shared through conversations and interactions between people.

Manage Project Knowledge Inputs:

1- **Project Management Plan**
2- **Project Documents**

- Documents includes (lessons learned register, project team assignments, resource breakdown structure and stakeholder register)
- Project team assignments provide information on the type of competencies and experience available in the project and the knowledge that may be missing

3- **Deliverables**
4- **Enterprise Environmental Factors**
5- **Organizational Process Assets**

Manage Project Knowledge Tools & Techniques:

1- **Expert Judgment**
2- **Knowledge Management**

- Knowledge Management tools can be applied face-to-face or virtually, or both. However Face-to-face interaction is usually the most effective way to build the trusting relationships.

3- Information Management

- Information management tools and techniques are used to create and connect people to information. Such as (**PMIS,** Lessons learned register)
- Tools and techniques that connect people to information can be enhanced by adding an element of interaction
- Communities of practice (called communities of interest) & SME's may generate insights that lead to improved control processes

4- Interpersonal and Team Skills

- **Active listening:** Helps reduce misunderstandings and improves communication and knowledge sharing
- **Facilitation:** Facilitation helps effectively guide a group to a successful decision or solution.
- **Leadership:** Communicate the vision and inspire the project team to focus on the appropriate knowledge and knowledge objectives.
- **Networking:** allows informal connections and relations among project stakeholders to be established and creates the conditions to share tacit and explicit knowledge
- **Political awareness:** helps the project manager to plan communications based on the project environment as well as the organization's political environment

Manage Project Knowledge Outputs:

1- Lessons learned register

- Lessons learned register may include category, description, impact, recommendations, proposed solutions, challenges, problems, realized risks and opportunities.
- lessons learned register is created as an output of this process **early** in the project.
- At the end of a project or phase, the information is transferred to an organizational process asset called lessons learned **repository**.
- Lessons learned should document both **reasons of failure and reasons of success**.

2- Project Management Plan Updated

3- Organizational Process Assets Updates

Monitor and Control Project Work (Monitor & Control Process Group)

Monitor and Control Project Work is the process of tracking, reviewing, and reporting the overall progress to meet the performance objectives defined in the project management plan.

Key benefits of this process are that it allows stakeholders to understand the current state of the project, to recognize the actions taken to address any performance issues, and to have visibility into the future project status with cost and schedule forecasts

- This process is performed throughout the project
- monitoring gives the project management team insight into the health of the project and identifies any areas that may require special attention
- Control includes corrective & preventive actions or replanning and following up on actions to determine if the issue has been resolved.
- This process includes (comparing actual performance with planned, check status of individual risks, provide forecast to update current cost and schedule information, monitor implantation of approved changes and provide reporting on the project).

Monitor and Control Project Work Inputs:

1- **Project Management Plan**

2- **Project Documents**

(Assumption log, Basis of estimates, cost forecasts, issue log, lessons learned register, milestone list, quality reports, risk register, risk report and schedule forecast)

3- **Work Performance Information**

Work performance data is gathered through work execution and passed to the controlling processes. To **become work performance information**, the work performance **data** are **compared** with the project management plan components and project documents. This comparison indicates how the project is performing.

4- **Agreements**

- Procurement agreement includes terms and conditions, and may incorporate other items that the buyer specifies regarding what the seller is to perform or provide. Project manager needs to oversee contractor's work to make sure all agreements are met

5- **Enterprise Environmental Factors**

6- **Organizational Process Assets**

Monitor and Control Project Work Tools and Techniques:

1- **Expert Judgment**

- Earned Value analysis, techniques to estimate durations and costs, trend analysis, risk management, contract management, technical knowledge on industry focus area.

2- **Data Analysis**

- **Alternative analysis:** Used to select the corrective actions or a combination of **corrective** and **preventive** actions to implement when a deviation occurs.
- **Cost-benefit analysis:** Helps to determine the best **corrective** action in terms of cost in case of project deviations.
- **Earned value analysis:** Provides an integrated perspective on scope schedule, and cost performance.
- **Root cause analysis:** Focuses on identifying the main reasons of a problem
- **Trend analysis:** Used to forecast future performance **based on past results**. looks ahead in the project for expected slippages and **warns** the project manager ahead of time. This information is made available **early** enough in the project timeline. The results of trend analysis can be used to recommend **preventive** actions if necessary.
- **Variance analysis:** reviews the differences (or variance) between planned and actual performance, such as (cost estimates, resources utilization, resources rates, technical performance). Variance analysis may be conducted in each Knowledge Area. This allows for the appropriate **preventive** or **corrective** actions to be initiated

3- **Decision Making**

- Voting: making decisions based on unanimity, majority, or plurality.

4- **Meetings**

- Meetings may be face-to-face, virtual, formal, or informal. Example groups and review meetings

Monitor and Control Project Work Outputs:

1- **Work Performance Reports**

- Work performance reports are the physical or electronic representation of work performance information intended to generate decisions, actions, or awareness.
- They are circulated to the project stakeholders through the communication processes as defined in the project **communications management plan**
- Examples of reports (status reports and progress reports)

2- **Change Requests**

3- **Project Management Plan Updates**

- Cost forecast, Issue log, Lessons learned register, Risk register and Schedule forecasts.

Perform Integrated Change Control (Monitor & Control Process Group)

Perform Integrated Change Control is the process of reviewing all change requests; approving changes and managing changes to deliverables, project documents, and the project management plan. This process reviews all requests for changes to project documents, deliverables, or the project management plan and determines the resolution of the change requests

Key Benefit it allows for documented changes within the project to be considered in an integrated manner while addressing overall project risk

- This process is performed throughout the project.
- The Perform Integrated Change Control process is conducted from project **start** through **completion** and is the **ultimate responsibility of the project manager**
- Changes may be requested by **any stakeholder** involved with the project and may occur at **any time** throughout the project life cycle
- Before the baselines are established, changes **are not required** to be formally changed
- Every Change request should be either approved, deferred or rejected.
- change control board (CCB): formally chartered group responsible for reviewing, evaluating, approving, deferring, or rejecting changes to the project
- Customer or sponsor approval may be **required** for **certain** change requests after **CCB approval**, unless **they are part of the CCB.**
- The steps when applying for change request are (Analyze the impact on all constraints, apply change request to CCB. If approved you should update the change log, change management plan, any subsidiary plans (time, cost, scope baselines) and lastly update the project management plan. If the request was rejected it's important to update the change log.

Perform Integrated Change Control Inputs:

1- Project Management Plan

- Change management plan: Describes how the change request will be formally authorized and roles and responsibilities for CCB
- Configuration management plan: Describes how the information about the items of the project will be recorded and updated. So the product/service remains consistent or operative.
- Scope baseline: provides the project and product definition
- Schedule baseline: used to assess the impact of the changes in the project schedule.
- Cost baseline: used to assess the impact of the changes to the project cost

2- Project Documents

- **Basis of estimates:** how the duration, cost, and resources estimates were **derived** and can be used to calculate the impact of the change in time, budget, and resources.
- **Requirements traceability matrix:** helps assess the **impact** of the change on the project scope
- **Risk report:** presents information on sources of overall and individual project risks involved by the change requested

3- Work Performance Reports

- include resource availability, schedule and cost data, earned value reports, and burnup or burndown charts

4- Change requests

- All Monitoring and controlling processes and some of executing processes produce change request.
- Change requests include
    - ❖ Corrective action: realigns the performance of project work with project management plan
    - ❖ Preventive action: ensures the future performance of the work aligned with project management plan
    - ❖ Defect repair: modify a nonconforming product or product component
    - ❖ Updates: changes to formally controlled project documents to reflect modified ideas

5- Enterprise Environmental Factors

6- Organizational Process Assets

Perform Integrated Change Control Tools & Techniques:

1- Expert Judgment

- Knowledge in Legislation and regulations, Legal and procurement, Configuration management and Risk management.

2- Change Control Tools

- Tool selection should be based on the needs of the project stakeholders including organizational and environmental considerations
    - ❖ Identify configuration item
    - ❖ Record and report configuration item status
    - ❖ Perform configuration item verification and audit
- Process will be (Identify changes, Document changes, decide on Changes and Track Changes)

3- Data Analysis

- **Alternative Analysis:** assess the requested changes and decide which are accepted, rejected, or need to be modified to be finally accepted.
- **Cost-benefit analysis:** determine if the requested change is worth its associated cost.

4- Decision Making

- **Voting:** take the form of unanimity, majority, or plurality to decide on whether to accept, defer or reject the change request
- **Autocratic decision making: O**ne individual takes the responsibility for making the decision for the entire group.
- **Multicriteria decision analysis:** uses a decision matrix to provide systematic analytical approach to evaluate the requested changes according to a set of predefined criteria

❖ **Unanimity:** everyone agrees on a single course of action
❖ **Majority:** obtained from more than 50% of the members of the group
❖ **Plurality:** decision is reached whereby the largest block in a group decided, even if a majority not achieved

5- Meetings

- CCB may review configuration management activities

Perform Integrated Change Control Outputs:

1- Approved Change Requests

- Approved change requests will be implemented through the Direct and Manage Project Process
- Deferred or rejected change requests are communicated to the person or group requesting the change
- The disposition of all change requests are recorded in the **change log** as a project document update.

2- Project Management Updates

- Any formally controlled component of the project management plan may be changed as a result of this process
- Changes to baselines are only made from the last baseline forward. Past performance is not changed. This protects the **integrity** of the baselines and the historical data of past performance.

3- Project Document Updates

- Any formally controlled project document may be changed as a result of this process.
- A project document that is normally updated as a result of this process is the **change log**

Close Project or Phase (Closing Process Group)

Close Project or Phase is the process of finalizing all activities for the project, phase, or contract.

Key benefits of this process are the project or phase information is archived, the planned work is completed, and organizational team resources are released to pursue new endeavors

- This process is performed once or at predefined points in the project
- When closing the project, the **project manager** reviews the project management plan to ensure that all project work is **completed** and the project **objectives** has been met
- Activities necessary for the **administrative closure** of the project/phase
  - ❖ Actions and activities necessary to satisfy **completion** or **exit criteria** for the phase such as (all documents are up-to-date and all issues are resolved, confirm delivery of formal accepted deliverables, ensure all costs are charged to the project, closing project documents, reassigning personnel, dealing with excess material, reallocating project equipment, do final project report)
  - ❖ Activities related to the completion of the contractual **agreements** applicable to project such as (Confirm formal acceptance of seller's work, finalize open claims, update record to reflect final results, archiving information for future use)
  - ❖ Activities needed to (collect project/phase records, Audit project success/failure, manage knowledge sharing/transfer, identify lessons learned, archive project information for future use)
  - ❖ Actions and activities necessary to transfer the project's products, services, or results to the next phase or to production and/or operations.
  - ❖ Collecting any suggestions for improving or updating the policies and procedures of the organization, and sending them to the appropriate organizational unit.
  - ❖ Measuring **stakeholder satisfaction**.
- investigate and document the reasons for actions taken if **a project is terminated before completion.** In order to successfully achieve this, the project manager needs to engage proper stakeholders in the process.

Close Project or Phase Inputs:

1- **Project Charter**
2- **Project Management Plan**
3- **Project Documents**

Such as (Assumption log, Basis of estimates, Change log, Issue log, Lessons learned register, Milestone list, Project communications, Quality control measurements, Quality reports, Requirements documentation, Risk register and Risk report)

4- **Accepted Deliverables**

- Approved product specifications, delivery receipts and work performance documents.
- **Partial** or **interim** deliverables may also be included for **phased** or **cancelled** projects

5- **Business Documents**

- **Business Case**: justify the project and determines if the expected outcomes from the economic feasibility study used to justify the project occurred
- **Benefits management plan**: used to measure whether the benefits of the project were achieved as planned.

6- **Agreements**

- Requirements for formal procurement closure are usually defined in the terms and conditions of the contract and are included in the procurement management plan
- complex project may involve managing multiple contracts simultaneously or in sequence.

7- **Procurement Documentation**

- To close the contract, all procurement documentation is collected, indexed, and filed.
- "As-built" plans/drawing or "as-developed" documents, manuals and troubleshooting considered as part of the procurement documents
- This information can be used for lessons learned and as a basis for evaluating future contracts

8- **Enterprise Environmental Factors**
9- **Organizational Process Assets**

Close Project or Phase Tools & Techniques:

1- **Expert Judgment**

- Management control, Audit, Legal and procurement and Legislation and regulations.

2- **Data Analysis**

- **Document analysis:** Assessing available documentation will allow identifying lessons learned and knowledge sharing for future projects

- **Regression analysis:** analyzes the interrelationships between different project variables that contributed to the project outcomes to improve performance on future projects.
- **Trend analysis:** validate the models used in the organization and to implement adjustments for future projects
- **Variance analysis:** Variance analysis can be used to improve the metrics of the organization by comparing what was initially planned and the end result

3- Meetings

- Examples: close-out reporting meetings, customer wrap-up meetings, lessons learned meetings and celebration meetings.

Close Project or Phase Outputs:

1- Project documents updates

- All project documents may be updated and marked as final versions
- Most important register is **lessons learned register**
- The final lessons learned register may include information on benefits management, accuracy of the business case, project and development life cycles, risk and issue management, stakeholder engagement, and other project management processes.

2- Final Product, Service or Result Transition

- Final product/service may be handed over to a different group or organization that will operate, maintain, and support it throughout its life cycle.

3- Final Report

- Includes information such as (description of the project/phase, scope objectives, quality objectives, Cost objectives, summary of validation information for the final product, Schedule objectives, summary how the project achieved business needs and summary for any risks)

4- Organizational Process Assets Updates:

- **Project documents:** Documentation resulting from the project's activities
- **Operational and support documents:** Documents required for an organization to maintain, operate, and support the product or service delivered by the project
- **Project or phase closure documents:** formal documentation that indicates completion of the project and overseen by Project manager
- **Lessons learned repository:** Lessons learned and knowledge gained throughout the project are transferred to the lessons learned repository for use by future projects

Chapter 5 (Project Scope Management)

Project Scope Management includes the processes required to ensure that the project includes all the **work required**, and **only** the work required. And it's concerned with defining and controlling what is and is not included in the project

Product Scope: features and functions that characterize a product, service, or result.
Project Scope: work performed to deliver a product, service, or result with the specified features and functions

- The term "project scope" is sometimes viewed as including product scope
- **Project** Scope is measured against the **Project Management Plan**
- **Product** Scope is measured against the **Product Requirements**
- Project life cycles can range along a continuum from predictive approaches at one end to adaptive or agile approaches at the other
- In **predictive** life cycle the deliverables are defined at the **beginning** of the project and any changes to the scope are **progressively** managed
- In adaptive/agile life cycle the deliverables are developed over multiple **iterations** where detailed scope is defined and approved for each **iteration when it begins**.
- Projects with **adaptive** life cycles are intended to respond to high levels of change and require ongoing stakeholder engagement
- Overall scope of an adaptive project will be decomposed into a set of **requirements** and **work to be performed**, sometimes referred to as a **product backlog**
- At beginning of each iteration the team determine how many of highest priority item on backlog can be delivered on next iteration. Three Process are repeated each iteration (Collect Requirements, Define Scope and Create WBS)
- In **predictive** life cycle Collect Requirements, Define Scope and Create WBS are performed at the **beginning** of the project and updated as necessary using change control process
- In **adaptive/agile** the **sponsor** and customer representatives should be **continuously engaged** with the project to provide feedback on deliverables
- In **predictive** projects, the scope baseline for the project is the approved version of the project scope statement, work breakdown structure (WBS), and its associated WBS dictionary
- **Business Analysis** are used in some organizations to defining, managing, and controlling **requirements** activities
- Activities of business analysis may start **before** a project is **initiated** and a project manager is assigned
- Project manager is responsible for ensuring that requirements-related work is accounted
- The relationship between a project manager and a business analyst should be a **collaborative partnership**
- Agile methods deliberately spend less time trying to define and agree on scope in the early stage of the project and spend more time establishing the process for its ongoing discovery and refinement
- In agile approaches, the requirements constitute the backlog.

Plan Scope Management (Planning Process Group)

Plan Scope Management is the process of creating a scope management plan that documents how the project and product scope will be defined, validated, and controlled

Key benefit of this process is that it provides **guidance** and direction on **how** scope will be managed throughout the project

- This process is performed **once** or at predefined points
- The development of the scope management plan and the detailing of the project scope **begin** with the **analysis** of information contained in the (**project charter,** latest approved subsidiary plans of the **project management plan, historical information** contained in OPA and EEF's)

Plan Scope Management Inputs:

1- Project Charter

- High-level project description assumptions, constraints, and high-level **requirements.**

2- Project Management Plan

- **Quality management plan**: The way the project will be managed is influenced by organization quality policy, methodologies, and standards
- **Project life cycle description**: determines the series of phases that a project passes through from its inception to the end of the project.
- **Development approach**: The development approach defines whether waterfall, iterative, adaptive, agile, or a hybrid development approach will be used

3- Enterprise Environmental Factors

4- Organizational Process Assets

Plan Scope Management Tools & Techniques:

1- Expert Judgment

- Previous similar projects and information in the industry, discipline and application area

2- Data Analysis

- Alternative Analysis: Various ways of collecting requirements, create, validate and control scope.

3- Meetings

- May include (Sponsor, project manager, team members and selected stakeholder)

Plan Scope Management Outputs:

1- Scope Management Plan

- Component of the project management plan that describes **how** the scope will be defined, developed, monitored, controlled, and validated
- Components includes processes that help (Preparing project scope statement, create WBS, how the baseline will be approved and maintained and how formal acceptance will be obtained)
- The scope management plan can be **formal** or **informal**, broadly framed or highly detailed

2- Requirements Management Plan

- The requirements management plan is a component of the project management plan that describes how project and product requirements will be analyzed, documented, and managed
- It's also referred as **Business Analysis Plan** according to Business analysis
- Components may include (Configuration management activities, Requirements prioritization, Metrics, Traceability structure and how requirements will be planned, tracked and reported)

    - ❖ Traceability structure reflects the requirement attributes captured on the traceability matrix.
    - ❖ Configuration management shows how changes will be initiated, how impacts will be analyzed, how they will be traced and reported and authorization levels to approve changes

Collect Requirements (Planning Process Group)

Collect Requirements is the process of determining, documenting, and managing stakeholder needs and requirements to meet objectives

Key benefit of this process is that it provides the basis for defining the product scope and project scope.

- This process is performed **once** or at predefined points
- The project's success is directly influenced by active stakeholder involvement in the discovery and decomposition of needs into project and product requirements
- Requirements include conditions or capabilities that are required to be present in a product to satisfy an agreement and business needs.
- Requirements need to be elicited, analyzed, and recorded in enough detail to be included in the scope baseline and to be measured once project execution begins
- Requirements become the foundation of the WBS Cost, schedule, quality planning, and procurement

Collect Requirements Inputs:

1- Project Charter

2- Project Management Plan

- Includes (Scope management plan, Requirements management plan and Stakeholder engagement plan)

❖ Stakeholder engagement plan: used to understand stakeholder communication requirements and the level of stakeholder engagement in order to assess stakeholder requirements

3- Project Documents

- Includes (Assumption Log, Lessons learned register and Stakeholder register)

❖ Stakeholder Register: used to identify stakeholders who can provide information on the requirements also captures requirements and expectations that stakeholders have for the project.

4- Business Documents

- Business Case influence this process as it describes required, desired, and optional criteria for meeting the business needs

5- Agreements

- contain project and product requirements.

6- Enterprise Environmental Factors

7- Organizational Process Assets

Collect Requirements Tools & Techniques:

1- Expert Judgment

- Experts specialized in (Business analysis, Requirements elicitation, Requirements analysis Requirements documentation, Project requirements in previous similar projects, Diagramming techniques, Facilitation, and Conflict management)

2- Data Gathering

- **Brainstorming**: used to generate and collect multiple ideas related to project/product requirements
- **Interviews**: Can be **formal** & **informal** to elicit information by talking directly to them, and is usually performed by asked prepared or spontaneous questions and recording the responses. Interviews are useful for obtaining **confidential** information. It may include individual/multiple interviewers/interviewees
- **Focus Groups:** Bring together prequalified stakeholders and subject matter experts to learn about their expectations and attitudes about proposed product/service. A **trained moderator** guides the group through interactive discussion to be more conversational than one-on-one interview
- **Questionnaires and surveys:** written set of questions designed to **quickly** accumulate information of **large** number of respondents. It's most appropriate with varied audiences, geographically dispersed for quick turnaround where statistical analysis could be appropriate.
- **Benchmarking:** Comparing actual or planned products and processes to those of comparable organizations (internal or external) to identify best practices, **generate ideas** for improvement and provide a basis for measuring performance

3- Data Analysis

- Document analysis which consists of reviewing and assessing any relevant documented information to **elicit** requirements by analyzing existing documentation and identifying information relevant to the requirements

4- Decision making

- **Voting:** Used to classify and prioritize product requirements. (**unanimity**, **majority** and **plurality**)
- **Autocratic decision making:** one individual takes responsibility for making the decision
- **Multicriteria decision analysis:** decision matrix to provide a systematic analytical approach for establishing criteria, such as risk levels, uncertainty, and valuation, to evaluate and rank many ideas

5- Data Presentation

- **Affinity diagrams:** allow **large** numbers of ideas to be **classified** into groups for review and analysis.
- **Mind mapping:** consolidates ideas created through individual **brainstorming** sessions into a single map to reflect **commonality and differences** in understanding and to **generate new ideas**.

6- Interpersonal and Team Skills

- **Nominal group technique:** Enhances brainstorming with a **voting** process used to **rank** the most useful ideas for further brainstorming or for **prioritization.** It includes four steps
    - ❖ Question is posed to the group. Each person silently generates and writes down their ideas
    - ❖ Moderator writes down the ideas on a **flip chart** until all ideas are recorded
    - ❖ Each recorded idea is discussed until all group members have a clear understanding
    - ❖ Individuals vote privately to **prioritize** the ideas. (Voting may take place in many rounds)

- **Observation and conversation (Job Shadowing):** Direct way of viewing individuals in their environment and how they perform their jobs. Usually used when people have difficulty or reluctant to articulate their requirements. Usually it's done externally by an **observer** viewing business expert performing the job. Also can be done by a **participant observer** who actually performs a process to experience how it's done and uncover hidden requirements

- **Facilitation:** Used with focused sessions that bring **key stakeholders** together to define product requirements. Workshops can be used to quickly define **cross-functional** requirements and **reconcile** stakeholder differences. This may increase stakeholder consensus and issues can be discovered earlier and resolved more quickly than in individual sessions. Examples
    - ❖ Joint application design/development (JAD) used in software development industry
    - ❖ Quality function deployment (QFD): using in manufacturing industry. It collects customer needs known as Voice of the Customer (VOC)
    - ❖ User stories: short, textual descriptions of required functionality developed during workshops

7- Context Diagram

Example of Scope model. Context diagrams visually depict the product scope by showing a business system and how people and other systems (actors) interact with it. They show inputs to the business system, the actor(s) providing the input, the outputs from the business system, and the actor(s) receiving the output

- ❖ Actor → Business System →Output → Actor

8- Prototypes

- Method of obtaining early feedback on requirements by providing a model of the expected product. Examples (computer generated 2D, 3D models, mock-ups and simulations)
- Prototypes support the concept of progressive elaboration
- **Storyboarding** is a prototyping technique showing sequence or navigation through a series of **images** or illustrations. Used in films, advertising

Collect Requirements Outputs:

1- Requirements Documentation

- Describes how individual requirements **meet the business need** for the project.
- Requirements may start out at a high level and become progressively more detailed as more information about the requirements is known.
- Requirements should be unambiguous (measurable and testable, traceable complete, consistent, and acceptable to key stakeholders)

Requirements can be classified into

- Business requirements
- Stakeholder requirements
- Solution requirements**:** Solution requirements grouped into functional (behavior of the product) & nonfunctional requirements (environmental qualities required to get an effective product)
- Transition and readiness requirements**:** Describe temporary capabilities
- Project requirements
- Quality requirements

2- Requirements Traceability Matrix

- Grid that **links** product **requirements** from their origin to the **deliverables** that satisfy them
- Ensure that each requirement adds business value by linking it to the business/project objectives
- Provides a means to track requirements throughout the project life cycle
- Helping to ensure that requirements approved in the requirements documentation are delivered at the end of the project
- Provides a structure for managing changes to the product scope
- Attributes associated with each requirement can be recorded in the requirements traceability matrix
- Matrix include unique identifier, a textual description of the requirement, the rationale for inclusion, owner source, priority, version, current status and status date
- Additional attributes to ensure that the requirement has met stakeholders' satisfaction may include stability, complexity, and acceptance

Define Scope (Planning Process Group)

Define Scope is the process of developing a detailed description of the project and product

key benefit of this process is that it describes the product, service, or result boundaries and acceptance criteria

- Since all the requirements identified in Collect Requirements may not be included in the project, the Define Scope process selects the final project requirements from the requirements documentation developed during the Collect Requirements process
- Develops a detailed description of the project and product, service, or result.
- The preparation of a detailed project scope statement builds upon the major deliverables, assumptions, and constraints that are documented during project initiation.
- Define Scope process can be **highly iterative**
- In iterative life cycle projects, a high-level vision will be developed for the overall project, but the detailed scope is determined one iteration at a time

Define Scope Inputs:

1- Project Charter

2- Project Management Plan

- **Scope management plan**: How the project scope will be defined, validated and controlled

3- Project Documents

- Includes (Assumption log, Requirements documentation and Risk register)

4- Enterprise Environmental Factors

5- Organizational Process Assets

Define Scope Tools & Techniques:

1- Knowledge Management

2- Data Analysis

- Alternatives Analysis: to meet the requirements and the objectives identified in the charter

3- Decision Making

- Multicriteria decision analysis

4- Interpersonal and Team Skills

- Facilitation:

5- Product Analysis

- Used to define products and services. It includes asking questions about a product or service
- Requirements are captured at a high level and decomposed to the level of detail needed to design the final product
- Examples include (Product breakdown, Requirements analysis, Systems analysis and engineering and value analysis and engineering)

<u>Define Scope Tools & Outputs:</u>

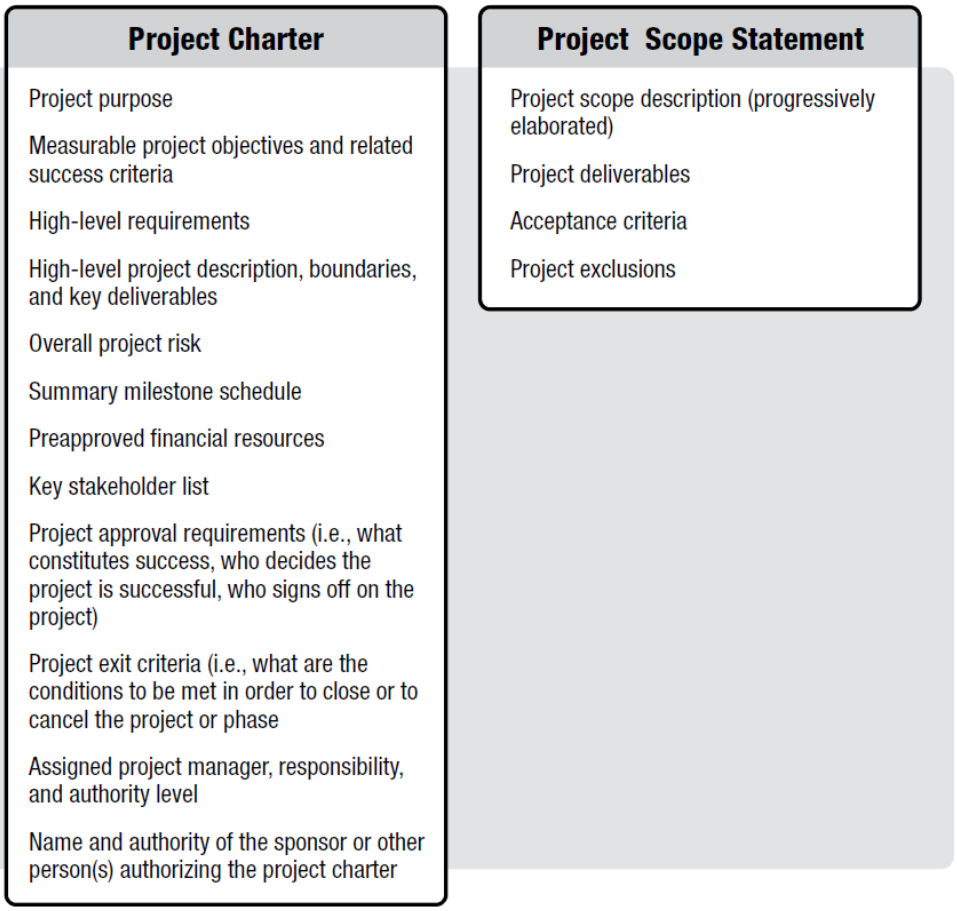
1- Project Scope Statement

- Description of the project scope, major deliverables, assumptions, and constraints.
- Project scope statement documents the **entire scope**, including project and product scope
- Provides a common understanding of the project scope among project stakeholders
- Project charter contains high level information while project scope statement includes detailed description of the scope components. They are progressively elaborated throughout the project

Project Scope Statement include (Product scope description, deliverables, acceptance criteria and project exclusions)

2- Project Document Updates

- Includes (Assumption log, Requirements documentation, Requirements traceability matrix and Stakeholder register)



Create WBS (Planning Process Group)

Create WBS is the process of subdividing project deliverables and project work into smaller, more manageable components.

Key benefit of this process is that it provides a framework of what has to be delivered

- This process is performed **once** or at predefined points
- WBS is a **hierarchical decomposition** of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables **(top-down approach**)
- WBS **organizes and** defines **the total scope** of the project and **represents** the work specified in the current approved project scope statement
- Planned work is contained within the **lowest level** of WBS components, which called **Work Packages**
- Work Package can be used to **group the activities** where work is scheduled and estimated, monitored, and controlled

Create WBS Inputs:

1- Project Management Plan

- Scope Management Plan

2- Project Documents

- Includes (Project scope statement and Requirements documentation)

3- Enterprise Environmental Factors

4- Organizational Process Assets

Create WBS Tools & Techniques:

1- Expert Judgment

2- Decomposition

- Technique used for dividing and subdividing the project scope and project deliverables into smaller, more manageable parts.
- The work package is the work defined at the **lowest** level of the WBS for which **cost** and **duration** can be estimated and managed.
- Popular methods to create WBS structure: **top-down** approach, the use of organization-specific guidelines, and the use of WBS templates
- **Bottom-up** approach can be used to group subcomponents

- Decomposition of the **upper-level WBS** components requires subdividing the work for each of the deliverables or subcomponents into its most fundamental components
- Agile approaches decompose **epics** to **user stories**
- Decomposition may not be possible for a deliverable or subcomponent that will be accomplished **far** into the **future** The project team usually waits until the deliverable or subcomponent is agreed on, so the details of the WBS can be developed. This technique called **rolling wave planning.**
- The total of the work at the lowest levels should roll up to the higher levels so that nothing is left out and no extra work is performed. This is sometimes called the **100 percent rule.**

Create WBS Outputs:

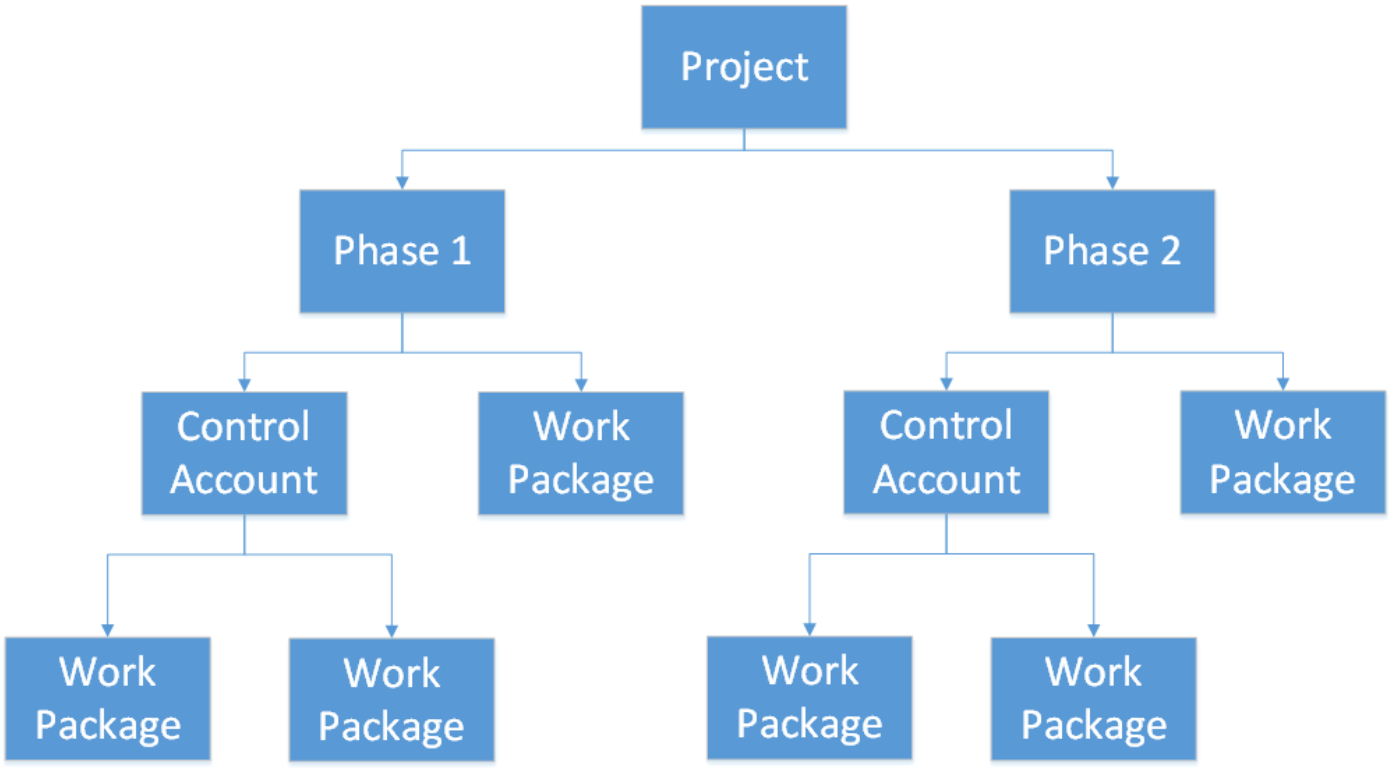
1- Scope Baseline

The scope baseline is the approved version of a scope statement, WBS, and its associated WBS dictionary and it's component of the project management plan. Scope baseline includes

- **Project scope statement:** description of the project scope, major deliverables and constraint.
- **WBS:** Hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables. Each **descending** level of the WBS represents an **increasingly** detailed definition of the project work.
- **Work package:** The lowest level of the WBS is work package with a unique identifier. Each work package is part of a **control account** which is a management control point where scope, budget, and schedule are integrated and compared to the earned value for performance measurement. Each control account has **two or more** work packages. But work package is associated with a single control account
- **Planning package:** Include one or more planning packages. A planning package is a WBS component **below** the control account and **above** the work package with known work content but **without detailed** schedule **activities**
- **WBS dictionary:** document that provides detailed deliverable, activity, and scheduling information about each component in the WBS. It's a document that support the WBS because you can't include all the information in the WBS. It contains (Codes, work description, assumption, milestones, associated activities, resources, cost, quality requirement, references)

2- Project Document Updates

- Includes (Assumption log and Requirements documentation)


Project
Phase 1
Phase 2
Control Account
Work Package
Control Account
Work Package
Work Package
Work Package
Work Package
Work Package

Validate Scope (Monitor and Controlling Process Group)

Validate Scope is the process of **formalizing acceptance** of the completed project deliverables

Key benefit of this process is that it brings objectivity to the acceptance process and increases the probability of final product, service, or result acceptance by validating each deliverable

- This process is performed periodically throughout the project as needed
- The **verified** deliverables obtained from the **Control Quality** process
- The verified deliverables are approved through this process by the customer or sponsor to get the **accepted deliverables**
- Validate Scope concerned with **acceptance** of the deliverables
- Control Quality concerned with **correctness** of the deliverables

Validate Scope Inputs:

1- Project Management Plan

Includes (Scope management plan, Requirements management plan and Scope baseline)

2- Project Documents

Includes (Lessons learned register, Quality reports, Requirements documentation and Requirements traceability matrix)

3- Verified deliverables

- Project deliverables that are completed and checked for correctness through Control Quality.

4- Work Performance Data

- include the degree of compliance with requirements, number of nonconformities severity of the nonconformities, or the number of validation cycles performed in a period of time

Validate Scope Tools & Techniques:

1- Inspection

Includes activities such as measuring, examining, and validating to determine whether work/deliverables meet requirements and product acceptance criteria. They might be called “reviews and walkthroughs)

2- Decision Making

- Voting

Validate Scope Outputs:

1- Accepted Deliverables

Deliverables that meet the acceptance criteria are formally **signed** and **approved** by customer/sponsor

2- Work Performance Information

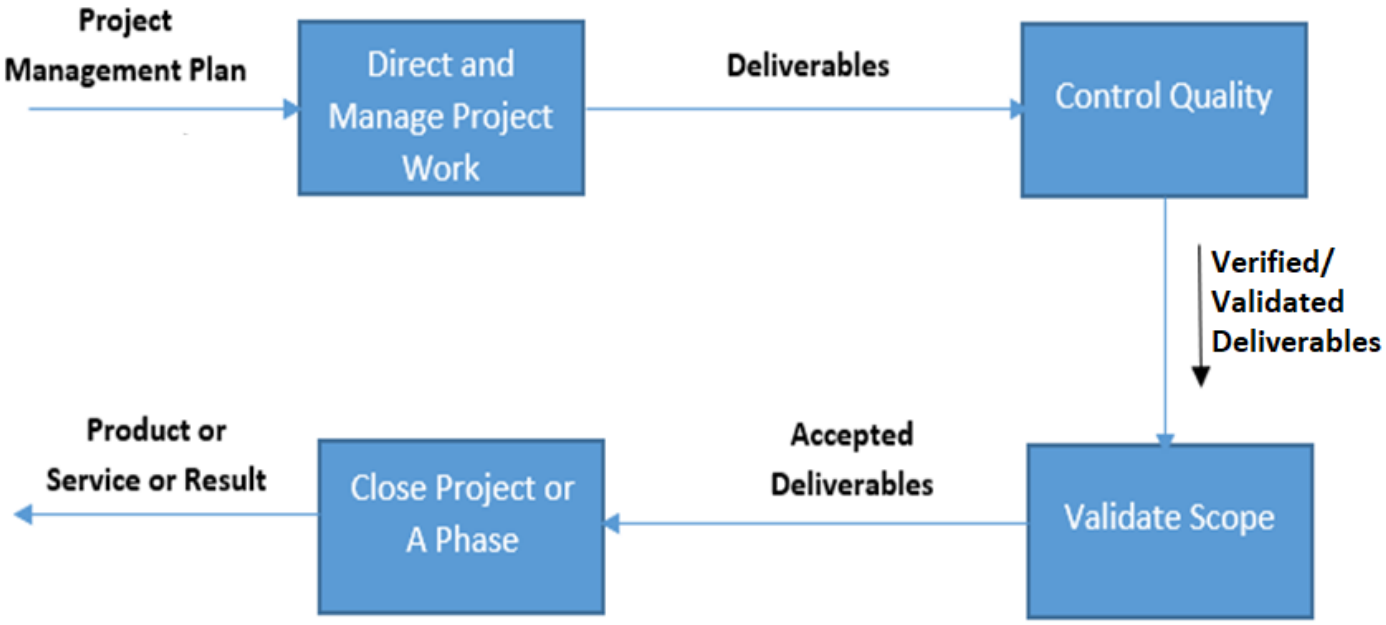
- includes information about project progress, such as which deliverables have been accepted and which have not been accepted and the reasons

3- Change Requests

- The completed deliverables that have **not** been formally accepted are documented, along with the reasons for non-acceptance of those deliverables Those deliverables may require a change request for **defect repair.**

4- Project Document Updates

Includes (Lessons learned register, Quality reports, Requirements documentation and Requirements traceability matrix)



Control Scope (Monitor and Controlling Process Group)

Control Scope is the process of monitoring the status of the project and product scope and managing changes to the scope baseline.

Key benefit of this process is that the scope baseline is maintained throughout the project.

- This process is performed **throughout** the project
- Controlling the project scope ensures all requested changes and recommended corrective or preventive actions are processed through the Perform Integrated Change
- Manage the actual changes when they occur and is integrated with the other control processes
- The **uncontrolled** expansion to product or project scope without adjustments to time, cost, and resources is referred to as **scope creep**

Control Scope Inputs:

1- Project Management Plan

- Includes (Scope management plan, Requirements management plan, Change management plan, Configuration management plan, Scope baseline and Performance measurement baseline)

❖ **Performance measurement baseline** When using earned value analysis, the performance measurement baseline is compared to actual results to determine if a change, corrective action, or preventive action is necessary

2- Project Documents

- Includes (Lessons learned register, Quality reports, Requirements documentation and Requirements traceability matrix)

3- Work Performance Data

- Work performance data can include the number of change requests received, the number of requests accepted, and the number of deliverables verified, validated, and completed

4- Organizational Process Assets

Control Scope Tools & Techniques:

1- Data Analysis

- **Variance analysis:** compare the baseline to the actual results and determine if the variance is within the threshold amount (Variance = Planned – Actual)
- **Trend analysis:** examines project performance over time to determine if performance is **improving** or **deteriorating**

Important aspects of project scope control include determining the **cause** and **degree** of variance relative to the scope baseline and deciding whether corrective or preventive action is required.

Control Scope Outputs:

1- Work Performance Information

- correlated and contextualized information on **how** the project and product scope are performing compared to the scope baseline.
- include the categories of the changes received, the identified scope variances and their causes, how they impact schedule or cost, and the forecast of the future scope performance

2- Change Requests

- Analysis of project performance may result in a change request to the scope and schedule baselines

3- Project Management Plan Updates

- Includes (Scope management plan, Scope baseline, Schedule baseline, Cost baseline and Performance measurement baseline)

4- Project Document Updates

- Includes (Lessons learned register, Quality reports, Requirements documentation and Requirements traceability matrix)

Chapter 6 (Project Schedule Management)

- Project scheduling provides a detailed plan that represents how and when the project will deliver the products services, and results defined in the project scope
- serves as a tool for communication, managing stakeholder's expectations, and as a basis for performance reporting
- The project management **team** selects a scheduling method, such as critical path or agile approach
- The project-specific data, such as the activities, planned dates, durations, resources, dependencies, and constraints, are entered into a scheduling tool to create a schedule model for the project. The result is a **project schedule**
- the detailed project schedule should remain **flexible** throughout the project to adjust for knowledge gained, increased understanding of the risk, and value-added activities.
- There are two main practicing for scheduling methods (Iterative scheduling with a backlog & On-demand scheduling.)
- **Iterative scheduling with a backlog** is a form of **rolling wave planning** based on **adaptive** life cycles where requirements are documents in user stories. This approach is often **used** to deliver incremental value to the customer or when multiple teams can concurrently develop a large number of features that have few interconnected dependencies. The **benefit** of this approach is that it **welcomes changes t**hroughout the development life cycle.
- **On-demand scheduling** used in a **Kanban system.** On-demand scheduling does not rely on a schedule that was developed previously but pulls work from a backlog or intermediate queue of work to be done immediately as **resources become available.** Tasks are relatively similar in size and scope. It's used in projects that evolve the product incrementally in operational environment
- Adaptive approaches use **short** cycles to undertake work, these cycles provide **rapid** feedback on the approaches and suitability of deliverables and generally manifest as **iterative** scheduling and on-demand, pull-based scheduling
- If a business analyst is assigned to a project, requirement-related activities are the responsibility of that role
- Eliciting, documenting and managing stakeholder requirements Is a responsibility of a business analyst in projects where business analysts collaborate with project managers to manage the project scope

Plan Schedule Management (Planning Process Group)

Plan Schedule Management is the process of establishing the policies, procedures, and documentation for planning, developing, managing, executing, and controlling the project schedule.

Key benefit of this process is that it provides guidance and direction on how the project schedule will be managed throughout the project.

- This process is performed once or at predefined points in the project

Plan Schedule Management Inputs:

1- Project Charter

- As it defines the **summary milestone** schedule that will influence the management of the schedule

2- Project Management Plan

- Includes Scope management plan and Development approach (schedule approach and techniques)

3- Enterprise Environmental Factors

4- Organizational Process Assets

Plan Schedule Management Tools and Techniques:

1- Expert Judgement

specialized knowledge in previous similar projects in development, methodologies and software.

2- Data Analysis

- Alternative analysis: determine which schedule methodology to use, or how to combine various methods on the project

3- Meetings

- Meeting may include: Project manager, Sponsor, team members and selected stakeholders

Plan Schedule Management Outputs:

1- Schedule Management Plan

- It maybe formal or informal, highly detailed, or broadly framed
- The schedule management plan is a component of the project management plan that establishes the criteria and the activities for developing, monitoring, and controlling the schedule. It includes;

- **Project schedule model development:** Scheduling methodology and tool to be used in the project

- **Release and iteration length:** In adaptive life cycle the time-boxed periods for releases, waves and iterations are specified.
    - ❖ **Time-boxed periods**: durations which the team works steadily toward completion of a goal, and this helps to **minimize scope creep**

- **Level of accuracy:** Specifies the acceptable range used in determining realistic activity durations

- **Units of measure:** Each unit of measurement is defined for each of the resources

- **Organizational procedures links:** WBS provides the framework for the schedule management plan allowing for consistency with the estimates and resulting schedules.

- **Project schedule model maintenance:** Update the status and record progress of the project

- **Control thresholds:** Variance thresholds for monitoring schedule performance to indicate an agreed-upon amount of variation to be allowed before some action needs to be taken. Usually in **%**

- **Rules of performance measurement:** Earned value management (EVM) or other measurement rules are set

- **Reporting formats.** The formats and frequency for the various schedule reports are defined.

Define Activities (Planning Process Group)

Define Activities is the process of identifying and documenting the specific actions to be performed to produce the project deliverables.

Key benefit of this process is that it **decomposes work packages** into schedule **activities** that provide a basis for estimating, scheduling, executing, monitoring, and controlling the project work.

- This Process is performed **throughout** the project

Define Activities Inputs:

1- Project Management Plan

- Includes (Schedule management plan and Scope baseline)

2- Enterprise Environmental Factors

- PMIS

3- Organizational Process Assets

Define Activities Tools & Techniques:

1- Expert Judgment

2- Decomposition

- Technique used for dividing and subdividing the project scope and project deliverables into smaller, more manageable parts. Activities represent the effort needed to complete a work package.
- The activity list, WBS, and WBS dictionary can be developed either **sequentially** or **concurrently**

3- Rolling Wave Planning

- Iterative planning technique in which the work to be accomplished in the **near** term is planned in **detail**, while work further in the future is planned at a higher level
- It is a form of progressive elaboration and it's applicable on work packages

4- Meetings

Define Activities Outputs:

1- Activity List

- Includes the schedule activities required on the project.
- Projects that use agile/rolling wave techniques the activity list will be updated **periodically**
- activity list includes activity identifier and scope of work description for each activity

2- Activity Attributes

- Identifies component associated with each activity which evolves over time
- At early stages it will include activity identifier, WBS ID, and activity name
- At later stages/completed will include descriptions, **predecessor**, activities, **successor** activities, logical relationships, **leads and lags** resource requirements, constraints, and assumptions.

3- Milestone List

- Significant point or event in a project which has **zero duration**
- They can be mandatory (required by contract) or optional

4- Change Requests

- Once the project has been baselined, the progressive elaboration of deliverables into activities may reveal work that **was not** initially part of the project baselines
- Change requests are processed through the Perform Integrated Change Control process

5- Project Management Updates

- Schedule baseline
- Cost baseline

Sequence Activities (Planning Process Group)

Sequence Activities is the process of identifying and documenting relationships among the project activities.

Key benefit of this process is that it defines the logical sequence of work to obtain the greatest efficiency given all project constraints.

- This process is performed **throughout** the project
- Every activity except the first and last should be connected to at least one **predecessor** and at least one **successor** activity with an appropriate **logical relationship**
- Leads and lags may be used to support realistic and achievable project schedule.
- **Sequence** Activities process concentrates on converting the project activities from a list to a diagram to act as a first step to publish the schedule baseline.

Sequence Activities Inputs:

1- Project Management Plan

- Includes Schedule management plan & Scope baseline

2- Project documents

- Includes (Activity attributes, Activity list, Assumption log and Milestone list)

3- Enterprise Environmental Factors

4- Organizational Process Assets

Sequence Activities Tools & Techniques:

1- Precedence Diagramming Method (PDM)

- Technique used for constructing a schedule model in which activities are represented by **nodes** and are **graphically linked** by one or more logical relationships to show the sequence in which the activities are to be performed
- **Predecessor** activity is an activity that logically comes **before** a dependent activity in a schedule
- PDM includes four types of dependencies or logical relationships
    - **Finish-to-start (FS):** successor activity cannot start until a predecessor activity has finished.
    - **Finish-to-finish (FF):** successor activity cannot finish until predecessor activity has finished
    - **Start-to-start (SS):** successor activity cannot start until a predecessor activity has started
    - **Start-to-finish (SF):** successor activity cannot finish until a predecessor activity has started
- Finish-to-start (FS) is the most commonly used type of precedence relationship
- Start –to-finish (SF) is the least used type of precedence relationship

- Two activities can have two logical relationships at the same time. However Multiple relationships between the same activities are **not recommended.** Usually the relationship with **highest impact** is selected

2- Dependency Determination and Integration

Dependencies may be characterized by the following attributes: mandatory or discretionary, internal or external. Dependency has four attributes, but two can be applicable at the same time in the following ways: mandatory external dependencies, mandatory internal dependencies, discretionary external dependencies, or discretionary internal dependencies. Determining the dependencies take place in Sequence Activities Process.

- **Mandatory dependencies:** are legally or contractually required. They often involve physical limitations. They often called "**hard logic** or hard **dependencies**"
- **Discretionary dependencies**: are established based on knowledge of best practices at some unusual aspect of the project where a specific sequence is desired. Some activities can occur at same time (parallel) but performing them in sequential order reduces the overall project risk. Discretionary dependencies they create **total float** values which can limit scheduling options. Discretionary dependencies also called "**logic**, preferential logic, or **soft** logic)
- **External dependencies:** involve a relationship between project activities **and non-project** activities and usually outside the project team's control.
- **Internal dependencies:** involve a precedence relationship between project activities and are generally inside the project team's control.

3- Leads and Lags

- Lead is the amount of time a successor activity can be advanced with respect to a predecessor activity. Lead is often represented as a **negative** value for lag in scheduling software (SS -10)
- Lag is the amount of time a successor activity will be delayed with respect to a predecessor activity. And it is often represented as a **Positive** value for lag in scheduling software (SS+ 10)

4- Project Management Information System (PMIS)

- Scheduling software that has the capability to help plan, organize the schedule like (MS Project & Primavera)

<u>Sequence Activities Tools & Outputs:</u>

1- Project Schedule Network Diagrams

- graphical representation of the logical relationships also refereed as dependencies
- Activities that have multiple **predecessor** activities indicate a path **convergence**. Activities that have multiple **successor** activities indicate a path **divergence**

2- <u>Project Documents updates</u>

- Includes (Activity attributes, Activity list, Assumption log and Millstone list)

Estimate Activity Duration (Planning Process Group)

Estimate Activity Durations is the process of estimating the number of work periods needed to complete individual activities with estimated resources

Key benefit of this process is that it provides the amount of time each activity will take to complete

- This process is performed throughout the project
- Estimating activity durations uses information from (Scope of work, required resources, skill levels, resources quantities, resource calendars, constraint, effort involved and resources types)
- Duration estimate is progressively elaborated and it considers quality and availability of data
- Usually the number of resources and skill proficiency of resources may determine the activity's duration
- It's not simple straight line or linear relationship when estimating the duration with resources

There are factors to consider when estimating the duration

- **Law of diminishing returns:** When one factor used to determine the effort required to produce a unit of work is increased while all other factors remain fixed a point will eventually be reached at which additions of that factor start to yield progressively **smaller** or **diminishing** increases in output.
- **Number of resources:** Increasing the number of resources to twice the original number of the resources does not always reduce the time by half, as it may increase extra duration due to risk
- **Advances in technology:** Increase in the output of a manufacturing plant may be achieved by procuring the latest advances in technology may impact duration and resource needs
- **Motivation of staff:** Project manager also needs to be aware of Student Syndrome (procrastination), when people start to apply themselves only at the last possible moment before the deadline, and **Parkinson's Law** where work expands to fill the time available for its completion

Estimate Activity Inputs:

1- Project Management Plan

- Includes (Schedule management plan and Scope baseline)

2- Project Documents

- Includes (Activity attributes, Activity list, Assumption log, Lessons learned register, Milestone list, Project team assignments, Resource breakdown structure, Resource calendars, Resource requirements and Risk register)

- ❖ Resource calendars influence the duration of schedule activities due to the resources availability, type and attributes. Resource calendars specify when and how long identified project resources will be available during the project

3- Enterprise Environmental Factors

4- Organizational Process Assets

<u>Estimate Activity Tools & Techniques:</u>

1- Expert Judgment

- Specialized knowledge in Schedule development and expertise in estimating

2- Analogous Estimating

- Technique for estimating the duration or cost of an activity or a project using **historical data.** It uses parameters from previous projects such as (duration, budget, size, weight, and complexity)
- Relies on **actual duration** of previous, similar projects
- This technique is used when there is a **limited** amount of detailed **information** about the project.
- Generally, less costly and **less time**-consuming than other techniques but it is also **less accurate**

3- Parametric Estimating

- Technique in which an **algorithm** is used to calculate cost or duration based on **historical data** and project **parameters**
- Uses a statistical relationship between historical data and other variables to calculate activity duration and cost
- Durations can be quantitatively determined by multiplying the quantity of work to be performed by the number of labor hours per unit of work
- This technique can produce higher levels of accuracy

4- Three-Point Estimating

Using three-point estimates helps define an approximate range for an activity's duration

- Most likely (tM): based on the duration of the activity given the resources likely to be assigned
- Optimistic (tO): based on analysis of the best-case scenario for the activity
- Pessimistic (tP): based on analysis of the worst-case scenario for the activity

Then expected duration (tE) can be calculated. One commonly used formula is **triangular distribution tE= (tO + tM + tP) / 3 . In Beta Distribution (PERT) tE= (tO + 4tM + tP) / 6**

- Triangular distribution is used when there is insufficient historical data or when using judgmental data. This technique provides an expected duration and clarify the range of uncertainty

5- Bottom-Up Estimating:

- Method of estimating project duration or cost by **aggregating** the estimates of the lower level components of the WBS.
- If an activity duration can't be estimated with reasonable confidence, the work within the activity is **decomposed** into more detail.
- These estimates are then aggregated into a total quantity for each of the activity's durations

6- Data Analysis

- **Alternatives analysis:** Helps in determining optimal approach for accomplishing project work by comparing various levels of resources capability, scheduling techniques &
- **Reserve analysis:** determine the amount of **contingency** and management reserve needed for the project. Duration estimates may include contingency reserves (schedule reserves,) to account schedule uncertainty.

  Contingency reserves are associated with the **known-unknowns** (unknown amount of work). It may be a **percentage** of estimated activity duration or **fixed** number of work periods.

  Management reserves are a specified amount of the project budget withheld for management control purposes and are reserved for unforeseen work that is within scope of the project. It addresses **unknown-unknowns** that can affect a project. However, Management reserve is **not** included in the schedule baseline but it is part of the overall project duration requirements.

7- Decision making

- Includes voting**,** but in agile projects variation of voting is used called **fist of five** where project manager asks the team to show their support by holding up closed fist (no support) up to five fingers (full support). The manager continues it until the team achieve consensus (three or more fingers)

8- Meetings

- In agile approach sprint/iteration planning discuss backlog items (user stories).

<u>Estimate Activity Outputs:</u>

1- Duration Estimates

- Quantitative assessments of the likely number of time periods that are required to complete an activity, phase or project and it does not include any lags
- The estimate can include range (value or percentage) (e.g. 7 weeks ± 1)

2- Basis of estimates

- Provide clear and complete understanding how the duration estimate was derived

3- Project Documents Updates

- Includes Activity attributes, Assumption log and Lessons learned register.

Develop Schedule (Planning Process Group)

Develop Schedule is the process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create a schedule model for project execution and monitoring and controlling

Key benefit of this process is that it generates a schedule model with planned dates for completing project.

- This process is performed **throughout** the project
- Developing an acceptable project schedule is an **iterative** process
- The schedule model determines planned start and finish dates for activities and milestones
- After activities has been determined, project staff is assigned to review the activities has no conflict with resource calendars or relationships

Develop Schedule Inputs:

1- Project Management Plan

- Includes (Schedule management plan and Scope baseline)

2- Project Documents

- Includes (Activity attributes, Activity list, Assumption log, Basis of estimates, Duration estimates, Lessons learned, Milestone list, Project schedule network diagrams, Project team assignments, Resource calendars, Resource requirements and Risk register)

3- Agreements

4- Enterprise Environmental Factors

5- Organizational Process Assets

Develop Schedule Tools & Techniques:

1- Schedule Network Analysis

- Technique used to generate the project schedule model and it's an iterative process
- Employs several other techniques such as critical path method, resource optimization techniques and modeling techniques
- Assessing the need to aggregate schedule reserves to reduce the probability of a schedule slip
- Reviewing the network to see if the critical path has high-risk activities or long lead items that would necessitate use of schedule reserves

2- Critical Path Method

- The critical path estimates the **minimum** project duration and determine the amount of schedule flexibility on the logical network paths within the schedule model
- The critical path is the sequence of activities that represents the **longest path through a project**, which determines the **shortest possible project duration**
- Schedule network analysis technique calculates early/late start/finish dates **without** regard of any resource limitations
- **Total** float (slack) is the amount of time an activity can be delayed without delaying the project completion date. On **a critical path the total float is zero.**
- **Free** float is the amount of time that a schedule activity can be delayed **without delaying** the early start date of any **successor** or violating a schedule constraint
- Positive total float is caused when the backward pass is calculated from a schedule constraint that is later than the early finish date that has been calculated during forward pass calculation (there is more time available for an activity in the project schedule.)
- Negative total float is caused when a constraint on the late dates is violated by duration and logic. Negative float analysis is a technique that helps to find possible accelerated ways of bringing a delayed schedule back on track.
- Negative Float - results when the time difference between the late dates and the early dates (start or finish) of an activity is negative. Negative float it means excess time is not available for an activity so that activity must have to start before their predecessor activities complete in order to meet a target finish date in a project schedule else the project is bound to be delayed.
- The critical path method is used to calculate the critical path(s) and the amount of total and free float or schedule flexibility on the logical network paths within the schedule model

3- Resource Optimization

Resource leveling: A technique in which start and finish dates are adjusted based on resource constraints with the goal **of balancing the demand for resources** with the available supply

- Resource leveling can be used when shared or critically required resources are available only at certain times or in limited quantities or over allocated
- Resource leveling can often cause the original **critical path to change**
- Available float is used for leveling resources.

Resource Smoothing: A technique that adjusts the activities of a schedule model such that the requirements for resources on the project **do not exceed certain predefined resource limits**

- Critical path is **not changed** and the completion date may not be delayed
- Activities with free and total float may only be delayed.
- Resource smoothing may not be able to optimize all resource
- Resource smoothing is very similar to resource leveling except smoothing uses total and free float

4- Data Analysis

- **What-if scenario analysis:** process of evaluating scenarios in order to predict their effect (positive or negative) on the project. It's used to computer the different scenarios that might affect the project.it helps in assessing the feasibility and address the impact on unexpected situations

- **Simulation:** models the combined effects of individual project risks and other sources of uncertainty to evaluate their potential impact on achieving project objectives. Most common technique is **Monte Carlo analysis.** Where risk and other uncertainties are used to calculate possible schedule outcome for the project. It involves calculating multiple work package durations with different sets of activity assumptions using probability distribution.

5- Leads and Lags

- Leads are used to advance a successor activity with respect to the predecessor activity.
- Lags are used where processes require a set period of time to elapse between the predecessors and successors without work or resource impact

6- Schedule Compression

Schedule compression techniques are used to shorten or accelerate the schedule duration without reducing the project scope in order to meet schedule constraints, imposed dates, or other schedule objectives. A helpful technique is the negative float analysis. Techniques that can be used:

- **Crashing:** Technique used to **shorten** the schedule duration for the least incremental cost by **adding resources**. Examples (overtime, additional resources). Crashing works only for activities on the **critical path** where additional resources will shorten the activity's duration. Crashing does not always produce a viable alternative and may result in increased risk and/or cost.

- **Fast Tracking:** compression technique in which activities or phases normally done in sequence are performed in **parallel** for at least a portion of their duration. Fast tracking may result in rework and increased risk. Fast tracking only works when activities **can be overlapped** to shorten duration at critical path. Fast tracking may also **increase project costs.**

7- Project Management Information System (PMIS)

- Include scheduling software that expedites the process of building a schedule model

8- Agile Release Planning

- Provides a **high-level summary timeline** of the release schedule (3-6 months)
- determines the number of iterations or sprints in the release, and allows the product owner and team to decide how much needs to be developed and how long it will take to have a releasable product based on business goals dependencies, and impediments.

Develop Schedule Outputs:

1- Schedule Baseline:

- Approved version of a schedule model that can be changed only through formal change procedure and used as comparison to actual results. And is part of project management plan

2- Project Schedule

- Output of a schedule model that presents linked activities with planned dates, durations milestones, and resources.
- If resource planning is done at an early stage, the project schedule remains preliminary until resource assignments have been confirmed and scheduled start and finish dates are established
- The project schedule may be presented in summary form, sometimes referred to as the **master schedule** or **milestone schedule**

Project schedule is usually presented in graphical form using one or more of the following formats:

- **Bar charts (Gantt Charts):** Represent schedule information where activities are listed on the vertical axis, dates are shown on the horizontal axis, and activity durations are shown as horizontal bars placed according to start and finish dates.
- **Milestone charts:** similar to bar charts, but only identify the scheduled start or completion of major deliverables and key external interfaces
- **Project schedule network diagrams (Pure logic diagram):** commonly presented in the activity-on-node diagram format showing activities and relationships **without a time scale.** usually show both the project network logic and the project's critical path schedule activities. Another presentation of it is time-scaled logic diagram: include a time scale and bars that represent the duration of activities with the logical relationships

3- Schedule Data

- collection of information for describing and controlling the schedule incudes (milestones, activities, attributes and documentation for assumptions and constraints). May also resource histograms and cash flow projections, order and delivery schedule.

4- Project Calendars

- Identifies working days and shifts that are available for scheduled activities. It distinguishes available working dates from periods that are not available for work. Project may have **more than one** project calendar. Calendars may be **updated**

5- Change Requests

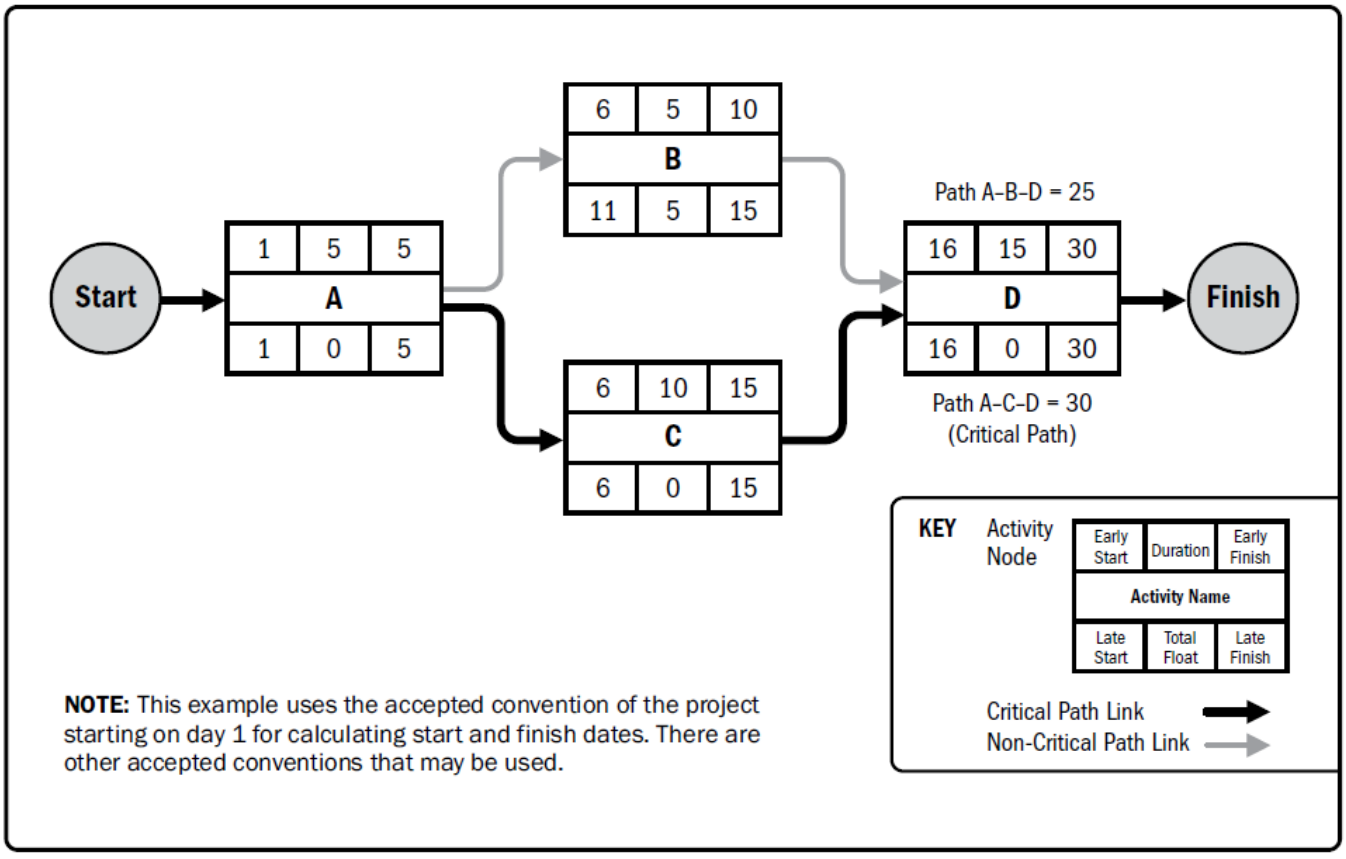
- Modifications to the project scope or project schedule may result in change requests
- Preventive actions may include recommended changes to eliminate or reduce the probability of negative schedule variances.

6- Project Management updates

- Includes Schedule management plan and Cost baseline

7- Project Documents Updates

- Includes activity attributes, Assumption log, Duration estimates, Lesson learned register, Resource requirements, Risk register



Example of Critical Path Method

Control Schedule (Monitor & Controlling Process Group)

Control Schedule is the process of monitoring the status of the project to update the project schedule and managing changes to the schedule baseline.

Key benefit of this process is that the schedule baseline is maintained throughout the project

- This process is performed throughout the project
- Updating the schedule model requires knowing the actual performance to date
- Regular and milestone status updates from contractors and suppliers are a means of ensuring the work is progressing as agreed upon to ensure the schedule is under control
- Reviews and walkthroughs should be done to ensure the contractor reports are accurate

Control Schedule Inputs:

1- Project Management Plan

- Includes (Schedule management plan, Schedule baseline, Scope baseline and Performance measurement baseline)

2- Project Documents

- Includes (Lessons learned register, Project calendars, Project schedule, Resource calendars and Schedule data)

3- Work Performance Data

- contains data on project status such as which activities have started, their progress and which activities have finished

4- Organizational Process Assets

Control Schedule Tools & Techniques:

1- Data Analysis

- **Earned Value Analysis:** Schedule performance measurements such as schedule variance (SV) and schedule performance index (SPI) are used to asses magnitude of variation to original baseline

- **Iteration Burndown Chart:** This chart tracks **the work that remains to be completed** in the iteration backlog. It analyzes the variance with respect to an ideal burndown based on work committed. A forecast trend line used to predict the likely variance, and diagonal line represent ideal burndown and daily actual remaining work is then plotted

- **Performance reviews:** Measure, compare, and analyze schedule performance against the schedule baseline
- **Trend analysis:** Examines project performance over time to determine whether performance is improving or deteriorating. Graphical analysis maybe used.
- **Variance analysis:** Variance analysis looks at variances in planned versus actual start and finish dates, planned versus actual durations, and variances in float. Also determine cause and degree of variance relative to baseline. And decide if corrective and preventive action is required.
- **What-if scenario analysis:** assess the various scenarios guided by the output from the Project Risk Management processes to bring the schedule model into alignment with the project management plan and approved baseline

2- Critical Path Method

3- Project Management Information System (PMIS)

4- Resource Optimization

5- Leads and Lags

6- Schedule Compression

<u>Control Schedule Outputs:</u>

1- Work Performance Information

- Work performance information includes information on how the project work is performing compared to the schedule baseline Variances. Variances can be calculated at work package level

2- Schedule Forecasts

- estimates or predictions of conditions and events in the project's future based on information and knowledge available at the time of the forecast
- The information is based on the project's past performance and expected future performance based on corrective or preventive actions
- This can include earned value performance indicators, and schedule reserve information

3- Change Requests

4- Project Management Plan Updates

- Includes Schedule management plan, Schedule baseline, Cost baseline and Performance measurement baseline

5- Project Document Updates

- Includes (Assumption log, Basis of estimates, Lessons learned register, Project schedule, Resource calendars, Risk register and Schedule data)

Chapter 7 (Project Cost Management)

- Project Cost Management is primarily concerned with the cost of the resources needed to complete project activities
- Recognize that different stakeholders measure project costs in different ways and at different times
- In small projects with small scope, cost estimating and cost budgeting can be viewed as single process at performed by a single person
- In agile environments lightweight estimation methods can be used to generate a fast, high-level forecast of project labor costs, which can then be easily adjusted as changes

Plan Cost Management (Planning Process Group)

Plan Cost Management is the process of defining how the project costs will be estimated, budgeted, managed monitored, and controlled.

Key benefit of this process is that it provides guidance and direction on how the project costs will be managed throughout the project

- This process is performed once or at predefined points in the project
- The cost management planning effort occurs early in project planning and sets the framework for each of the cost management processes so that processes performance will be efficient and coordinated

Plan Cost Management Inputs:

1- Project Charter

- Provides the preapproved financial resources from which the detailed project costs are developed
- Defines the project approval requirements that will influence the management of project costs

2- Project Management Plan

- Includes (Schedule management plan and Risk management plan)

3- Enterprise Environmental Factors

4- Organizational Process Assets

Plan Cost Management Tools & Techniques:

1- Expert Judgment

2- Data Analysis

- Alternative Analysis: Review strategic funding (self-funding, funding with equity or debt) and include considerations to acquire project resources (making, purchasing, renting and leasing)

3- Meetings

Plan Cost Management Outputs:

1- Cost Management Plan

- cost management plan is a component of the project management plan and describes how the project costs will be planned, structured, and controlled.

Cost management plan can establish the following

- **Units of measure:** Time measures (hours, days, weeks). Quantity measures (meters, liters, tons) or lump sum
- **Level of precision:** Degree to which cost estimates will be rounded up or down
- **Level of accuracy:** Acceptable range used in determining realistic cost estimates
- **Organizational procedures links**: WBS provides the framework for the cost management plan, allowing for consistency with the estimates, budgets, and control of costs.
- **Control thresholds:** Variance thresholds for monitoring cost performance may be specified to indicate an agreed-upon amount of variation to be allowed before some action needs to be taken and usually expressed as percentage
- **Rules of performance measurement:** Earned value management (EVM) rules of performance measurement are set. Cost management plan may define WBS points which measurement of control will be performed, Establish EVM techniques (weighted, milestone) and specify tracking methodologies and EVM computation
- **Reporting Formats:** Formats and frequency for the various cost reports are defined.
- **Additional details:** Additional details about cost management activities include description of strategic funding choices, currency exchange rate and project cost recording

Estimate Costs (Planning Process Group)

Estimate Costs is the process of developing an approximation of the cost of resources needed to complete project work.

Key benefit of this process is that it determines the monetary resources required for the project

- This process is performed periodically throughout the project as needed.
- A cost estimate is a quantitative assessment of the likely costs for resources required to complete the activity
- Cost estimates include the identification and consideration of costing alternatives to initiate and complete the project
- Cost trade-offs and risks should be considered to achieve optimal costs for the project
- Cost estimates are generally expressed in units of some currency or time measure units
- The accuracy of a project estimate will increase as the project progresses through project life cycle
- In project initiation phase have a rough **order of magnitude (ROM)** estimate in the range of (-25% to +75%). Later in projects when more information is known **definitive** estimate could narrow the range to (-5% to +10%)

Estimate Costs Inputs:

1- Project Management Plan

- Includes (Cost management plan, Quality management plan and Scope baseline)

2- Project Documents

- Includes (Lessons learned register, Project schedule, Resource requirements and Risk register)

3- Enterprise Environmental Factors

4- Organizational Process Assets

Estimate Costs Tools & Techniques:

1- Expert Judgment

2- Analogous Estimating

- Uses values, or attributes, of **a previous project** that are similar to the current project

3- Parametric Estimation

- Uses a statistical relationship between relevant historical data and other variables to calculate a cost estimate for project work. It produces higher level of accuracy (e.g., square footage in construction)

4- Bottom-UP Estimating

- Bottom-up estimating is a method of estimating a component of work.
- The cost of individual work packages or activities is estimated to the greatest level of specified detail
- Detailed cost is then summarized or "rolled up" to higher levels
- The cost and accuracy of bottom-up cost estimating are typically influenced by the size or other attributes of the individual activity or work package.

5- Three-Point Estimating

- Expected cost (cE) can be calculated using (Most Likely (cM), Optimistic (cO), Pessimistic (cP))
- For **Triangular distribution. cE = (cO + cM+ cP) / 3**
- For **Beta distribution (PERT) cE = (cO + 4cM+ cP) / 6**

6- Data Analysis

- **Alternative Analysis**: technique used to evaluate identified options in order to select which options to use to execute and perform the work of the project
- **Reserve Analysis:** Cost estimates may include contingency reserves (contingency allowances) to account for cost uncertainty. And intended to address known-unknowns
  Contingency reserves are the budget within the cost baseline that is allocated for identified risks
  Contingency reserves can be provided at any level from the specific activity to the entire project.
  Contingency reserve may be a percentage of the estimated cost, a fixed number, or may be developed by using quantitative analysis methods.
  When more information is available, the contingency reserve may be used, reduced or eliminated.

- **Cost of Quality:** Assumptions about costs of quality may be used to prepare the estimates. Which includes evaluating the cost impact of additional investment in conformance versus the cost of nonconformance. It also may include looking at short-term cost reductions vs of more frequent problems later on in the product life cycle.

7- Project Management Information System (PMIS)

- Spreadsheets, simulation software, and statistical analysis.

8- Decision Making

- Voting

Estimate Costs Outputs:

1- Cost Estimates

- Cost estimates include quantitative assessments of the probable costs required to complete project work and contingency amounts to account for identified risks, and management reserve to cover unplanned work
- Costs are estimated for all resources that are applied to the cost estimate.
- Cost estimates can be presented in summary form or in detail

2- Basis of Estimates

- Supporting documentation should provide a clear and complete understanding of how the cost estimate was derived (assumptions, constraints, risks, estimate range and confidence level)

3- Project Documents Updates

- Includes (Assumption log, Lessons learned register and Risk register)

Determine Budget (Planning Process Group)

Determine Budget is the process of aggregating the estimated costs of individual activities or work packages to establish an authorized cost baseline

Key benefit of this process is that it determines the cost baseline against which project performance can be monitored and controlled

- This process is performed once or at predefined points in the project.
- Project budget includes all the funds authorized to execute the project.

Determine Budget Inputs:

1- Project Management Plan

- Includes (Cost management plan, Resource management plan and Scope baseline)

2- Project Documents

- Includes (Basis of estimates, Cost estimate, Project schedule and Risk register)

3- Business Documents

- Business case: identifies the critical success factors for the project like financial success factors
- Benefits management plan: includes the target benefits, such as net present value calculations, timeframe for realizing benefits, and the metrics associated with the benefits

4- Agreements

5- Enterprise Environmental Factors

6- Organizational Process Assets

Determine Budget Tools & Techniques:

1- Expert Judgment

2- Cost Aggregation

- Cost estimates are aggregated by work packages in accordance with the WBS. The work package cost estimates are then aggregated for the higher component levels of the WBS and ultimately for the entire project

3- Data Analysis

- Reserve Analysis: Establish the management reserves for the project.
- Management reserves are an amount of the project budget withheld for management control purposes and are reserved for unforeseen work that is within scope of the project
- Management reserves are intended to address the **unknown unknowns** that can affect a project.
- Management reserve is **not included in the cost baseline** but is **part** of the overall project **budget**
- When an amount of management reserves is used to, it should be then added to cost baseline (require an approved change process)

4- Historical Information Review

- Reviewing historical information can assist in parametric or analogous estimates
- Historical information may include project characteristics (parameters) to develop mathematical models to predict total project costs

5- Funding limit Reconciliation

- The expenditure of funds should be reconciled with any funding limits on the commitment of funds for the project
- Variance sometimes necessitate the rescheduling of work and this is accomplished by placing imposed date constraints for work into project schedule

6- Financing

- Financing entails acquiring funding for projects for long lasting projects. External funding may require certain requirements.

<u>Determine Budget Outputs:</u>

1- Cost Baseline

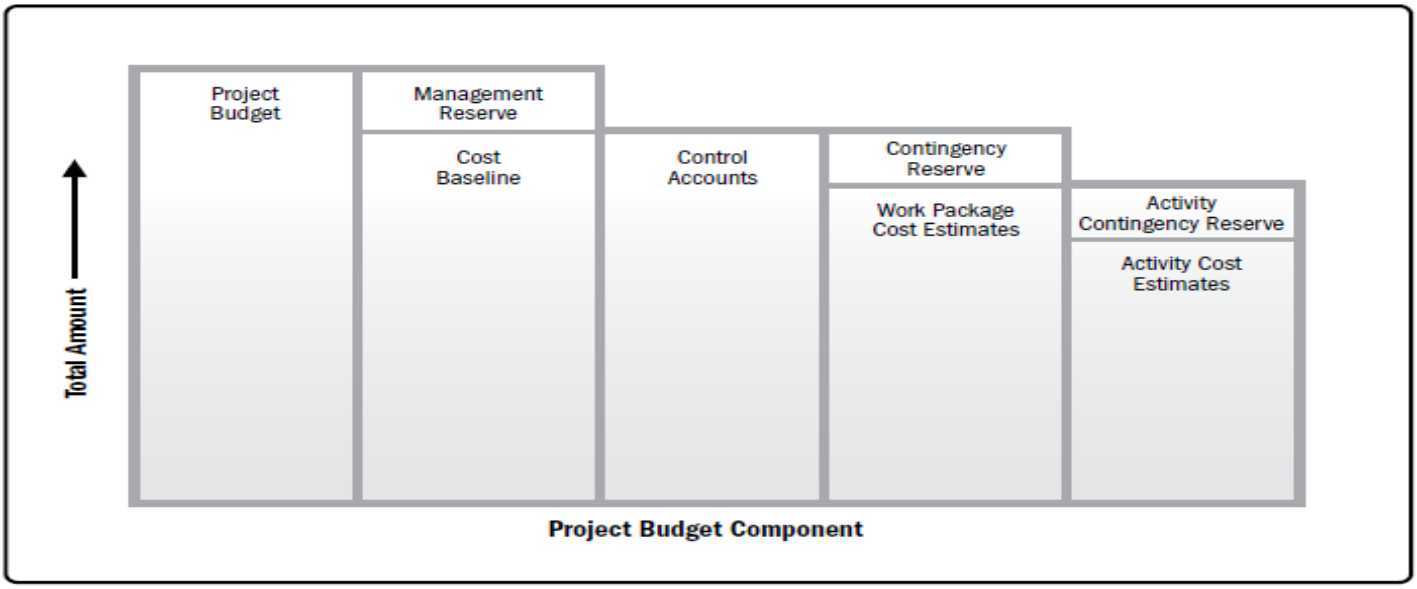
- Approved version of the time-phased project budget, excluding any management reserves. is used as a basis for comparison to actual results.
- It is developed as a of the approved budgets for the different schedule activities
- The work package cost estimates, along with any contingency reserves estimated for the work packages, are aggregated into **control accounts**. The summation of the control accounts makes up the cost baseline.
- Time-phased view of the cost baseline is typically displayed in the form of an **S-curve**
- For projects that use earned value management, the cost baseline is referred to as the performance measurement baseline

2- Project Funding Requirements

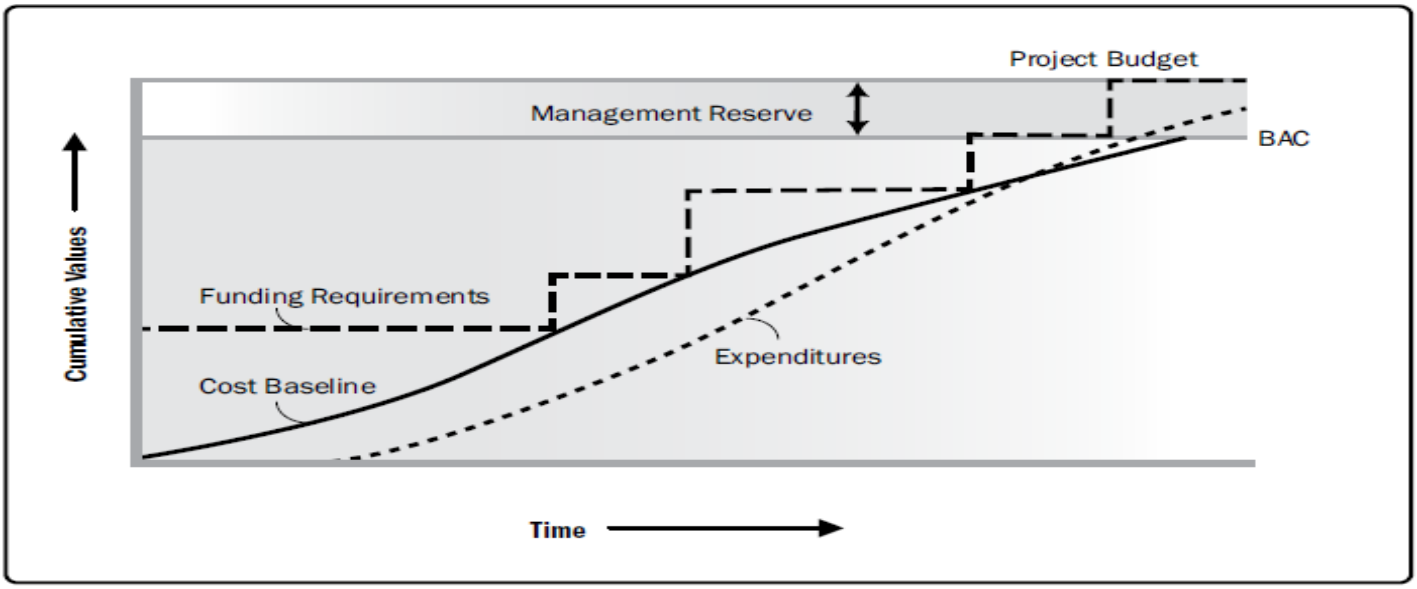
- Total funding requirements and periodic funding requirements (e.g., quarterly, annually) are derived from the cost baseline.
- Funding often occurs in incremental amounts, and may not be evenly distributed.

3- Project Management Updates

- Includes (Cost estimates, Project schedule and Risk register)



Project Budget Components



Control Costs (Monitor and Controlling Process Group)

Control Costs is the process of monitoring the status of the project to update the project costs and managing changes to the cost baseline.

Key benefit of this process is that the cost baseline is maintained throughout the project

- This process is performed throughout the project
- Any increase to the authorized budget require an approved change

Control Costs Inputs:

1- Project Management Plan

- Includes (Cost management plan, Cost baseline and Performance measurement baseline)

2- Project Documents

- Includes lessons learned register

3- Work Performance Data

4- Enterprise Environmental Factors

5- Organizational Process Assets

Control Costs Tools & Techniques:

1- Expert Judgement

2- Data Analysis

- **Earned value analysis (EVA):** compares the performance measurement baseline to the actual schedule and cost performance. EVM integrates the scope baseline with cost and schedule baselines to form the **performance measurement baseline.** It monitors three key dimensions
  - ❖ Planned Value (PV)
  - ❖ Earned Value (EV)
  - ❖ Actual Cost (AC)

- **Variance Analysis:** Cost and schedule variances are the most frequently analyzed measurements. Cost performance measurements are used to assess the magnitude of variation to the cost baseline and decide whether corrective or preventive action is required. Examples of variance analysis.

- ❖ Schedule Variance (SV)
- ❖ Cost Variance (CV)
- ❖ Schedule Performance Index (SPI)
- ❖ Cost Performance Index (CPI)

- **Trend Analysis:** examines project performance over time to determine if performance is improving or deteriorating. Graphical analysis techniques are valuable for understanding performance and comparison to future performance goals in the form of BAC vs EAC. Example of techniques

  - ❖ **Charts:** In earned value analysis, three parameters of planned value, earned value, and actual cost can be monitored and reported
  - ❖ **Forecasting:** Project team may develop a forecast for the estimate at completion (EAC) that may differ from the budget at completion (BAC). Forecasts are generated updated, and reissued based on work performance data. And work performance information covers the project's past performance and any information that could impact the project in the future.
    Most common EAC forecasting approach is a manual, bottom-up summation
    Bottom-up EAC builds upon the actual costs and experience incurred for the work completed, and requires a new estimate to complete the remaining project work
    Manual EAC is quickly compared with a range of calculated EACs representing various risk scenarios. Manual forecast more accurate to determine remaining works

    When calculating EAC the most common methods are
    - EAC forecast for ETC work performed at the budgeted rate
    - EAC forecast for ETC work performed at the present CPI
    - EAC forecast for ETC work considering both SPI and CPI factors

- **Reserve Analysis:** reserve analysis is used to monitor the status of contingency and management reserves for the project to determine if these reserves are still needed or if additional reserves need to be requested.
  These reserve may be used as planned to cover cost of risk response. Conversely, when opportunities are captured and resulting in cost savings, funds may be added to the contingency amount, or taken from the project as margin/profit.

3- To-Complete Performance Index (TCPI)

Measure of the cost performance that is required to be achieved with the remaining resources in order to meet a specified management goal expressed as the ratio of the cost to finish the outstanding work to the remaining budget

4- Project Management Information System (PMIS)

Earned Value Analysis

Abbreviation	Name	Lexicon Definition	How Used	Equation	Interpretation of Result
PV	Planned Value	The authorized budget assigned to scheduled work.	The value of the work planned to be completed to a point in time, usually the data date, or project completion.		
EV	Earned Value	The measure of work performed expressed in terms of the budget authorized for that work.	The planned value of all the work completed (earned) to a point in time, usually the data date, without reference to actual costs.	EV = sum of the planned value of completed work	
AC	Actual Cost	The realized cost incurred for the work performed on an activity during a specific time period.	The actual cost of all the work completed to a point in time, usually the data date.		
BAC	Budget at Completion	The sum of all budgets established for the work to be performed.	The value of total planned work, the project cost baseline.		
CV	Cost Variance	The amount of budget deficit or surplus at a given point in time, expressed as the difference between the earned value and the actual cost.	The difference between the value of work completed to a point in time, usually the data date, and the actual costs to the same point in time.	CV = EV – AC	Positive = Under planned cost Neutral = On planned cost Negative = Over planned cost
SV	Schedule Variance	The amount by which the project is ahead or behind the planned delivery date, at a given point in time, expressed as the difference between the earned value and the planned value.	The difference between the work completed to a point in time, usually the data date, and the work planned to be completed to the same point in time.	SV = EV – PV	Positive = Ahead of Schedule Neutral = On schedule Negative = Behind Schedule
VAC	Variance at Completion	A projection of the amount of budget deficit or surplus, expressed as the difference between the budget at completion and the estimate at completion.	The estimated difference in cost at the completion of the project.	VAC = BAC – EAC	Positive = Under planned cost Neutral = On planned cost Negative = Over planned cost
CPI	Cost Performance Index	A measure of the cost efficiency of budgeted resources expressed as the ratio of earned value to actual cost.	A CPI of 1.0 means the project is exactly on budget, that the work actually done so far is exactly the same as the cost so far. Other values show the percentage of how much costs are over or under the budgeted amount for work accomplished.	CPI = EV/AC	Greater than 1.0 = Under planned cost Exactly 1.0 = On planned cost Less than 1.0 = Over planned cost
SPI	Schedule Performance Index	A measure of schedule efficiency expressed as the ratio of earned value to planned value.	An SPI of 1.0 means that the project is exactly on schedule, that the work actually done so far is exactly the same as the work planned to be done so far. Other values show the percentage of how much costs are over or under the budgeted amount for work planned.	SPI = EV/PV	Greater than 1.0 = Ahead of schedule Exactly 1.0 = On schedule Less than 1.0 = Behind schedule
EAC	Estimate At Completion	The expected total cost of completing all work expressed as the sum of the actual cost to date and the estimate to complete.	If the CPI is expected to be the same for the remainder of the project, EAC can be calculated using: If future work will be accomplished at the planned rate, use: If the initial plan is no longer valid, use: If both the CPI and SPI influence the remaining work, use:	EAC = BAC/CPI EAC = AC + BAC – EV EAC = AC + Bottom-up ETC EAC = AC + [(BAC – EV)/(CPI x SPI)]	
ETC	Estimate to Complete	The expected cost to finish all the remaining project work.	Assuming work is proceeding on plan, the cost of completing the remaining authorized work can be calculated using: Reestimate the remaining work from the bottom up.	ETC = EAC – AC ETC = Reestimate	
TCPI	To Complete Performance Index	A measure of the cost performance that must be achieved with the remaining resources in order to meet a specified management goal, expressed as the ratio of the cost to finish the outstanding work to the budget available.	The efficiency that must be maintained in order to complete on plan. The efficiency that must be maintained in order to complete the current EAC.	TCPI = (BAC–EV)/(BAC – AC) TCPI = (BAC – EV)/(EAC – AC)	Greater than 1.0 = Harder to complete Exactly 1.0 = Same to complete Less than 1.0 = Easier to complete Greater than 1.0 = Harder to complete Exactly 1.0 = Same to complete Less than 1.0 = Easier to complete

Control Costs Outputs:

1- Work Performance Information

- Includes information on how the project work is performing compared to the cost baseline
- Variances in the work performed and the cost of the work are evaluated at the work package level and control account level
- projects using earned value analysis, CV, CPI, EAC, VAC, and TCPI are documented for inclusion in work performance reports

2- Cost Forecasts

- Either a calculated EAC value or a bottom-up EAC value is documented and communicated to stakeholders

3- Change Requests

4- Project Management Plan Updates

- Includes (Cost management plan, Cost baseline and Performance measurement baseline)

5- Project Document Updates

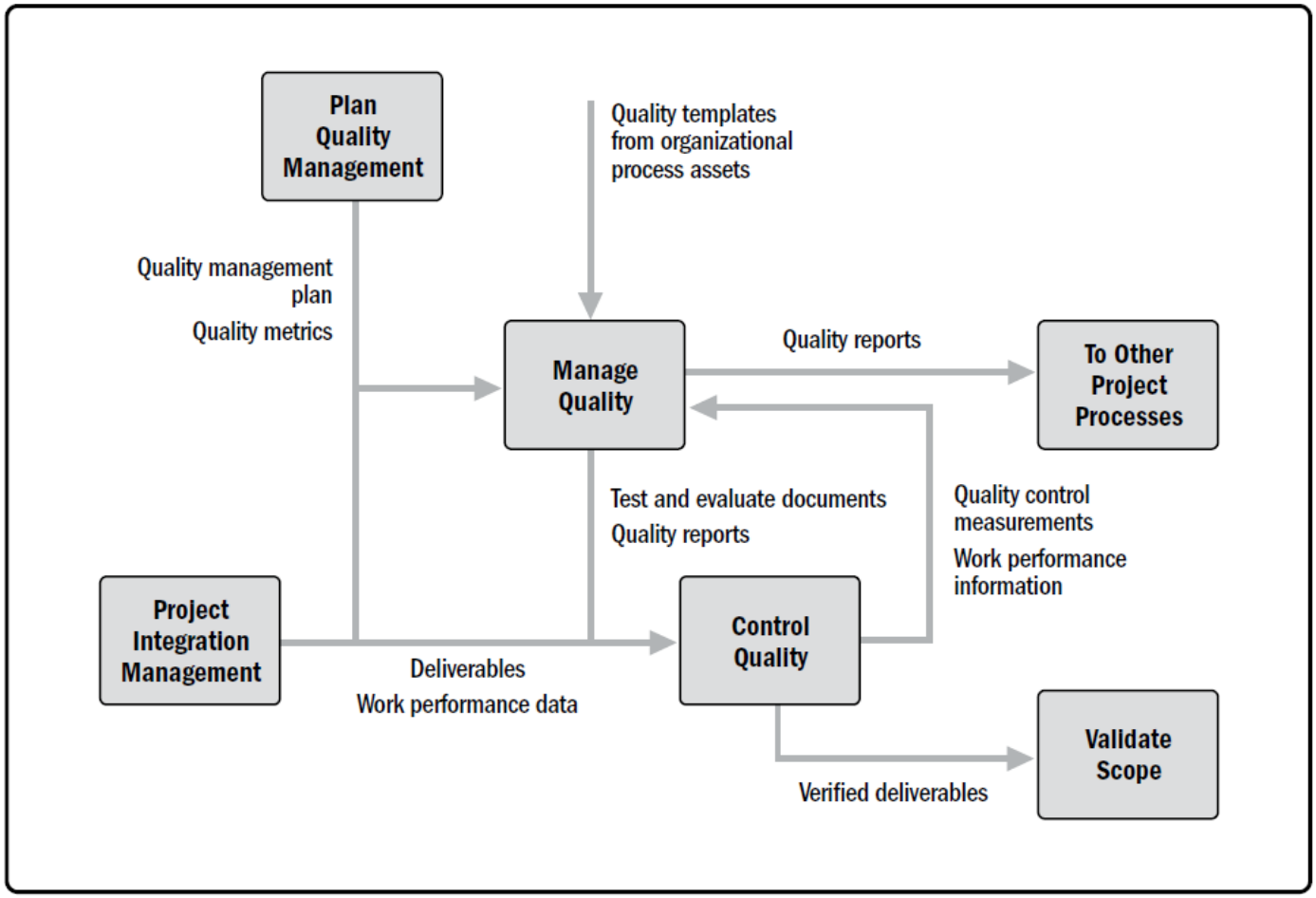
- Includes (Assumption log, Basis of estimates, Cost estimates, Lessons learned register and Risk register)

Chapter 8 (Project Quality Management)

- Project Quality Management addresses the management of the project and the deliverables of the project
- Failure to meet the quality requirements can have serious negative consequences for any or all of the project stakeholders (decreased profit and undetected errors)
- Quality as a delivered performance or result is the degree to which a set of inherent characteristics fulfill requirements
- Grade as a design intent is a category assigned to deliverables having the same functional use but different technical characteristics
- Project manager is responsible for managing trade-offs between quality and grade. Sometimes it's ok to have low-grade product with high quality, but a problem to have high-grade product with low quality
- Prevention is preferred over inspection. The cost of preventing mistakes is generally much less than the cost of correcting mistakes when they are found by inspection or during usage.
- **Prevention** (keeping errors out of the process) and **inspection** (keeping errors out of the hands of the customer)
- **Attribute sampling** (the result either conforms or does not conform) and **variable sampling** (the result is rated on a continuous scale that measures the degree of conformity);
- **Tolerances** (specified range of acceptable results) and **control limits** (that identify the boundaries of common variation in a statistically stable process or process performance
- Cost of quality (COQ) includes all costs incurred over the life of the product
- Failure costs also called cost of poor quality and they can be internal (found by the team) and external (found by the customer)
- Because projects are temporary, decisions about the COQ over a product's life cycle are often the concern of program management, portfolio management, the PMO, or operations.
- Effective quality management can be done in five ways
    - ❖ Let the customer find defects (most expensive) and voids warranty
    - ❖ Detect them before product sent to customer
    - ❖ Use quality assurance to examine and correct the process itself
    - ❖ Incorporate quality into the planning and designing of the project and product
    - ❖ Create a culture at organization that is aware and committed to quality in processes
- Quality management seeds to minimize variation and deliver results that meet stakeholder requirements. Trends in project quality management includes
    - ❖ Customer satisfaction: This requires conformance to requirements and fitness for use
    - ❖ Continual improvement: The plan-do-check-act (**PDCA**) cycle is the basis for quality improvement as defined by Shewhart and modified by Deming. Also TQM, Six Sigma and Lean Six Sigma can improve project and product quality

- ❖ Management responsibility: Success requires the participation of project team
- ❖ Mutually beneficial partnership with suppliers: The organization should prefer long-term relationships over short-term gain. mutually beneficial relationship enhances the ability for both the organization and the suppliers

- In agile projects it calls for frequent quality and review steps built in throughout the project rather than toward the end of the project.
- In agile projects they focus on small batches of work that aims to uncover inconsistencies and quality issues earlier in the project life cycle when overall cost is lower
- In agile environments Recurring **retrospectives** regularly check on the effectiveness of the quality processes. As they look for the root cause of the issue and suggest trials on new approaches.



Major Project Quality Management Process Interrelations

Plan Quality Management (Planning Process Group)

Plan Quality Management is the process of identifying quality requirements and/or standards for the project and its deliverables, and documenting how the project will demonstrate compliance with quality requirements and/or standards

Key benefit of this process is that it provides guidance and direction on how quality will be managed and verified throughout the project

- This process is performed once or at predefined points in the project
- Quality planning should be performed in parallel with the other planning processes

Plan Quality Management Inputs:

1- Project Charter

- Contains the project approval requirements, measurable project objectives, and related success criteria that will influence the quality management of the project

2- Project Management Plan

- Includes (Requirements management plan, Risk management plan, Stakeholder engagement plan and Scope baseline)

3- Project Documents

- Includes (Assumption log, Requirements documentation, Requirements traceability matrix, Risk register and Stakeholder register)

4- Enterprise Environmental Factors

5- Organizational Process Assets

Plan Quality Management Tools & Techniques:

1- Expert Judgment

- Knowledge in Quality (assurance, control, measurements, improvements and systems)

2- Data Gathering

- **Benchmarking:** comparing actual or planned project practices or the project's quality standards to those of **comparable projects** (Internal or external) to identify best practices, generate ideas for improvement, and provide basis for measuring performance.

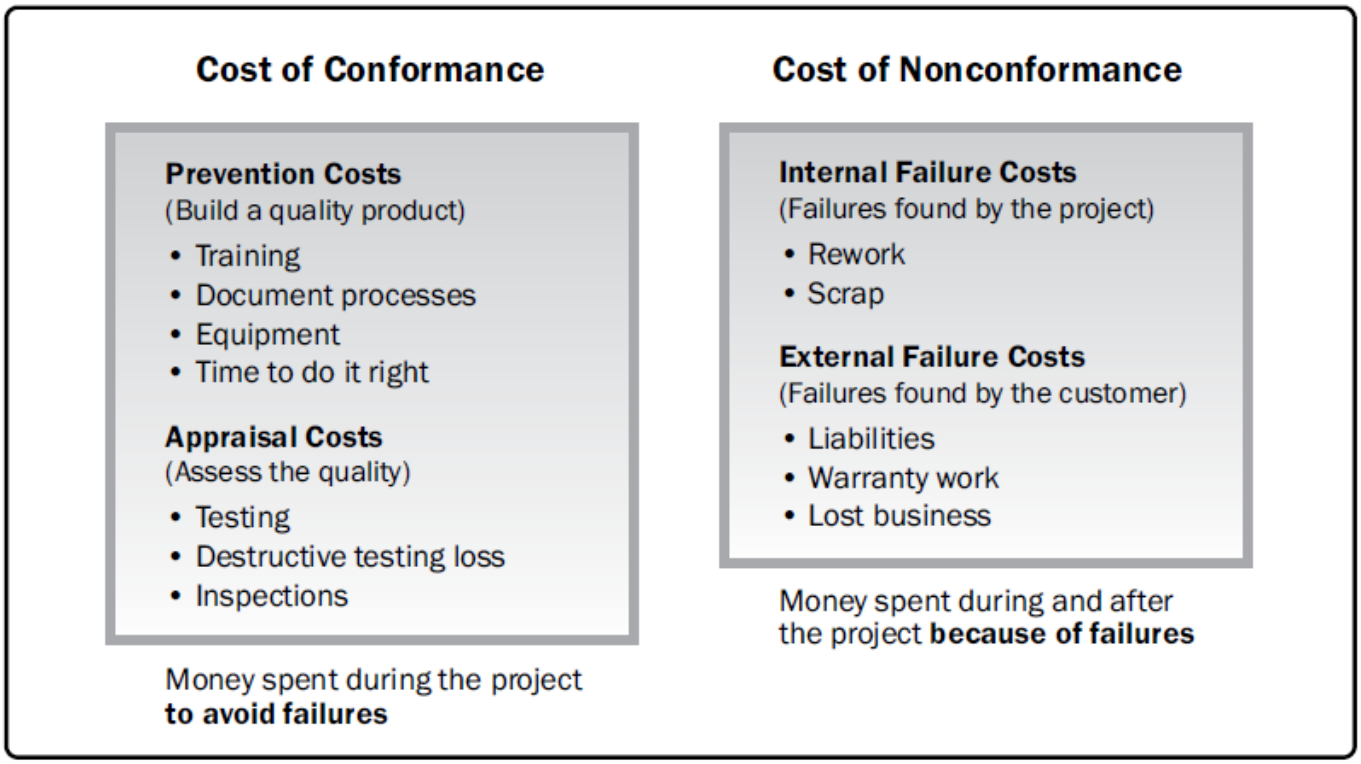
- **Brainstorming:** gather data creatively from a group of team members or subject matter experts to develop the quality management plan that best fits the project
- **Interviews: I**nterviewing experienced project participants, stakeholders and subject matter experts to identify project quality needs and expectations

3- Data Analysis:

- **Cost-benefit analysis:** Financial analysis tool used to estimate the **strengths and weaknesses** of **alternatives** in order to determine the best alternative in terms of benefits provided. It will help Project manager to determine if the planned quality is cost effective.
  Primary benefits of meeting quality requirements include less rework, higher productivity, lower costs, increased stakeholder satisfaction, and increased profitability

- **Cost of Quality (COQ):** consists one or more of the following costs
  - **Prevention costs:** Costs related to the prevention of poor quality in the products, deliverables, or services of the specific project.
  - **Appraisal costs***:* Costs related to evaluating, measuring, auditing, and testing the products, deliverables, or services of the specific project.
  - **Failure costs** (internal/external): Costs related to **nonconformance** of the products, deliverables, or services to the needs or expectations of the stakeholders

The optimal COQ is one that reflects the appropriate balance for investing in the cost of prevention and appraisal to **avoid failure costs**. Models show that there is an optimal quality cost for projects, where investing in additional prevention/appraisal costs is **neither beneficial nor cost effective.**



4- Decision Making

- Multicriteria decision: can be used to identify the key issues and suitable alternatives to be prioritized as a set of decisions for implementation (Example prioritization matrix). The alternatives are then ranked by score. As used in this process, it can help prioritize quality metrics

5- Data Representation

- **Flow Charts (process maps):**

❖ Display the sequence of steps and the branching possibilities that exist for a process that transforms one or more inputs into one or more outputs.

❖ It shows activities, decision points, loops, parallel paths, and the overall order of processing by mapping the operational details of procedures that exist within a horizontal value chain. One version of value chain is called **SIPOC** (suppliers, inputs, process, outputs and customers) model.

❖ Flowcharts are useful in understanding and **estimating the cost of quality for a process**

❖ Information is obtained by using the workflow branching logic to estimate the expected monetary value for the conformance and nonconformance work required to deliver the expected output

❖ They can be called (process flows or process flow diagrams) when they used to represent the steps in a process. Which is used for process improvement and **identify quality defects**

- **Logical data model:** Visual representation of an organization's data, described in business language and independent of any specific technology. Can be used to identify where **data integrity** or other quality **issues** can arise

- **Matrix diagrams:** Help find the strength of relationships among different factors, causes, and objectives that exist between the rows and columns that form the matrix. Project manager can use different shapes of matrix (L,T,Y,X,C, roof shape) depending on factors will be compared. process they facilitate identifying the **key quality metrics** that are important for the success of the project.

- **Mind mapping:** Diagrammatic method used to visually organize information. It is often created around a single quality concept, drawn as an image in the center of a blank landscape page, to which associated representations of ideas such as images words. The mind-mapping technique may help in the **rapid gathering** of project quality requirements, constraints and relationships.

6- Test and Inspection planning

- During planning phase, the project manager and the team determine how to test/inspect the product to meet the stakeholders' expectations and meet product's performance and reliability goal.
- The tests and inspections are industry dependent and can include (alpha and beta in software projects), (strength tests in construction projects), (inspection in manufacturing) and field tests and nondestructive tests in engineering.

7- Meetings

8- <u>Plan Quality Management Outputs:</u>

1- Quality Management Plan

- Describes how applicable policies, procedures, and guidelines will be implemented to achieve the quality objectives
- Describes the **activities and resources necessary** for the project management team to **achieve** the **quality** objectives set for the project
- It could be formal or informal, detailed, or broadly framed
- It should be reviewed early in the project to ensure that decisions are based on accurate information. benefits of this review can include a sharper focus on the project's value proposition, reductions in costs, and less frequent schedule overruns that are caused by rework
- Quality management plan may include quality (standards, objectives, roles and responsibilities, control, tools, review) and how to deal with nonconformance, corrective actions and continuous improvement procedures

2- Quality Metrics

- Describes a project or **product attribute** and how the Control Quality process will verify compliance to it. Examples (percentage of completed tasks, failure rate, defects number, errors found, cost performance measured by CPI)

3- Project Management Plan Updates

- Includes (Risk management plan and Scope baseline). Any update to these documents should go through change control process

4- Project Documents Updates

- Includes (Lessons learned register, Requirements traceability matrix, Risk register and Stakeholder register)

Manage Quality (Executing Process Group)

Manage Quality is the process of translating the quality management plan into executable quality activities that incorporate the organization's quality policies into the project.

Key benefits of this process are that it increases the probability of meeting the quality objectives as well as identifying ineffective processes and causes of poor quality

- This process is performed throughout the project
- Manage Quality is sometimes called **quality assurance.** although Manage Quality has a broader definition than quality assurance as it is used in nonproject work
- Quality assurance focuses on the processes used in the project and using these processes effectively by follow and meeting standards
- Manage quality includes all the quality assurance activities **and** also concerned with the product design aspects and process improvements
- Manage quality will fall under the conformance work category in the cost of quality framework.
- Manage quality helps in designing and optimal project, build confidence in future products, quality processes meets quality objectives and improve efficiency and effectiveness
- Manage Quality is considered the work of everybody. In agile projects quality management is performed by all team members. However, in traditional projects only specific members does it

Manage Quality Management Inputs:

1- Project Management Plan

- Includes Quality management plan which defines acceptable level of project quality and also describe how to do with nonconforming products and what corrective actions to implement

2- Project Documents

- Includes (Lessons learned register, Quality control measurements, Quality metrics and Risk report)

3- Organizational Process Assets

Manage Quality Management Tools & Techniques:

1- Data Gathering

- **Checklists:** structured tool, usually component-specific, used to verify that a set of required steps has been performed or to check if a list of requirements has been satisfied. Quality checklists should incorporate with scope baseline. Usually developed based on **historical information**

2- Data Analysis

- **Alternative analysis:** evaluate identified options in order to select which different quality options or approaches are most appropriate to use.
- **Document analysis:** analysis of different documents produced as part of the output of project control processes (quality reports, test reports, performance reports and variance reports). It focuses on processes that may be out of control and may jeopardize meeting the specified requirements or stakeholders' expectations
- **Process analysis:** identifies **opportunities** for process improvements also examines problems, constraints, and **non-value-added** activities that occur during a process
- **Root cause analysis (RCA):** analytical technique used to determine the basic underlying **reason** that causes a variance, defect, or risk. It may underlie more than one variance and it may also use to solve these root causes.

3- Decision Making

- **Multicriteria decision**: evaluate several criteria when discussing alternatives that impact project or product quality.

4- Data Representation

- **Affinity diagrams:** organize potential causes of defects into groups showing areas that should be focused on the most
- **Cause-and-effect diagrams:** Also **known** as fishbone diagrams, why-why diagrams, or Ishikawa diagrams. These diagrams break down the causes of the problem statement identified into discrete branches, helping to identify the **main or root cause** of the problem
- **Flowcharts:** show a series of steps that lead to a defect
- **Histograms:** graphical representation of **numerical data**. Histograms can show the number of defects per deliverable, a **ranking** of the cause of defects, the number of times each process is noncompliant or other representations of project or product defects
- **Matrix diagrams:** show the strength of relationships among factors, causes, and objectives that exist between the rows and columns that form the matrix.
- **Scatter diagrams:** graph that shows the relationship between **two variables**. Scatter diagrams can demonstrate a relationship between any element of a process, environment, or activity on one axis and a quality defect on the other axis.

5- Audits

- Structured, independent process used to determine if project activities **comply** with organizational and project **policies**, **processes**, and **procedures**
- Usually conducted by a team external to the project such as (organization's internal audit department, PMO or an external auditor to the organization)
- Confirm **the implementation of approved change requests** including updates, corrective actions defect repairs, and preventive actions
- The subsequent effort to correct any deficiencies should result in a reduced cost of quality and an increase in sponsor or customer acceptance of the product
- Quality audits may be scheduled or random, and may be conducted by internal or external auditors.

6- Design for X (DfX)

- Technical guidelines that may be applied during the **design** of a product for the optimization of a specific aspect of the design.
- DfX can control or even improve the product's **final characteristics**
- DfX result in cost reduction, quality improvement, better performance, and customer satisfaction.

7- Problem Solving:

- Finding solutions for issues or challenges. It includes gathering additional information, critical thinking, creative, quantitative and/or logical approaches.
- Effective and systematic problem solving is a fundamental element in quality assurance and quality improvement
- Problems can arise as a result of the Control Quality process or from quality audits and can be associated with a process or deliverable

8- Quality Improvement Methods

- Occur based on findings and recommendations from quality control processes, the findings of the quality audits, or problem solving in the Manage Quality process
- **Plan-do-check-act** and **Six Sigma** are two of the most common quality improvement tools used to analyze and evaluate opportunities for improvement.

Manage Quality Management Outputs:

1- Quality Reports

- Reports can be graphical, numerical, or qualitative.
- Reports information can be used by other processes to take **corrective** actions to achieve quality expectations
- Reports may include all quality management issues escalated by the team; recommendations for process, project, and product improvements; corrective actions recommendations the summary of findings from the Control Quality process

2- Test and Evaluation Documents

- Inputs to the Control Quality process and are used to evaluate the achievement of quality objectives
- They may include dedicated checklists and detailed requirements traceability matrices
- They can be created based on industry needs and the organization's templates

3- Change Requests

- If changes occur during the process that impact any components of the project management plan, project documents, or project or product management processes. Project manager should submit a change request and follow the Perform Integrated Change Control process

4- Project Management Plan Updates

- Includes (Quality management plan, Scope baseline, Schedule baseline and Cost baseline)

5- Project Documents Updates

- Includes (Risk register, Lessons learned register and Risk register)

Control Quality (Monitor & Controlling Process Group)

Control Quality is the process of monitoring and recording results of executing the quality management activities in order to assess performance and ensure the project outputs are complete, correct, and meet customer expectations

Key benefit of this process is verifying that project deliverables and work meet the requirements specified by key stakeholders for final acceptance.

- This process is performed throughout the project
- Control quality determines if the project outputs do what they were intended to do. Those outputs need to comply with all applicable standards, requirements, regulations, and specifications
- Control Quality process is performed to measure the **completeness, compliance, and fitness** for use of a product/service prior to user acceptance and final delivery
- Control quality in agile projects can be performed by all team members throughout the project life cycle. However, in waterfall projects it's performed at specific times, toward the end of the project or phase, by specified team members

Control Quality Management Inputs:

1- Project Management Plan

- Includes Quality management plan which defines how quality control will be performed

2- Project Documents

- Includes (Lessons learned register, Quality metrics and Test and evaluation documents)

3- Approved Change Requests

- Such as modifications, defect repairs and revised work methods

4- Deliverables

- Deliverables that are outputs from the Direct and Manage Project Work process are inspected and compared to the acceptance criteria defined in the project scope statement.

5- Work Performance Data

- Contains data on product status such as observations, quality metrics, and technical measurements, as well as project quality information on schedule and cost performance.

6- Enterprise Environmental Factors

7- Organizational Process Assets

Control Quality Management Tools & Techniques:

1- Data Gathering

- **Checklists:** help in managing the control quality activities in a structured manner
- **Check sheets (Tally sheets):** organize facts in a manner that will facilitate the effective collection of useful data about a potential quality problem. They are especially useful for gathering **attributes data** while performing inspections to identify defects
- **Statistical sampling:** involves choosing part of a population of interest for inspection. The sample is taken to measure controls and verify quality. Sample frequency and sizes should be determined during the Plan Quality Management process.
- **Questionnaires and Surveys:** gather data about customer satisfaction after the deployment of the product or service. The cost regarding defects identified in the surveys may be considered **external** failure costs in the COQ model and can have extensive cost implications for the organization

2- Data analysis

- **Performance reviews:** measure, compare, and analyze the quality metrics defined by the Plan Quality Management process against the actual results.
- **Root cause analysis (RCA):** used to identify the source of defects.

3- Inspection

- Determine if the product **conforms to documented standards**
- They can be done on single activity or at final product
- Inspection can be called **reviews**, peer reviews, audits, or **walkthroughs**.
- Inspections also are used to verify defect repairs

4- Testing/Product Evolutions

- organized and constructed investigation conducted to provide objective information about the quality the product or service under test in accordance with the project requirements.
- Intent of testing is to **find errors, defects, bugs**, or other nonconformance problems in the product
- Tests amount and type depend on the nature of the project, time, budget, and other constraints.
- Testing can be performed throughout the project and the end of the project.
- Early testing helps identify nonconformance problems and helps reduce the cost of fixing the nonconforming components

5- Data Representation

- **Cause-and-effect diagrams (Ishikawa or Fishbone):** identify the possible effects of quality defects and errors
- **Histogram:** demonstrate the number of defects by source or by component.
- **Scatter diagrams:** show the planned performance on one axis and the actual performance on the second axis

- **Control charts:**

❖ Determine whether or not a process is **stable** or has predictable performance.

❖ Upper and lower specification limits are based on the requirements and reflect the maximum and minimum values allowed.

❖ Upper and lower control limits are different from specification limits

❖ The control limits are determined using standard statistical calculations and principles to ultimately establish the natural capability for a stable process

❖ Project manager and appropriate stakeholder use controlled control limits which corrective action will be taken to prevent performance that remains outside control limits.

❖ Control charts can be used to monitor various types of output variables to help determine if the project management process are in control

❖ The sample out of control if there are 7 values either above or below the mean. Or if there is any value outside the control limits

6- Meetings

- **Approved change requests review:** All approved change requests should be reviewed to verify that they were implemented as approved
- **Retrospectives/lesson learned:** Meeting held to discuss (successful elements, what could be improved, what to incorporate in the ongoing project and what to add to OPA)

<u>Control Quality Management Outputs:</u>

1- Quality Control Measurements

- Documented results of Control Quality activities. They should be captured in the format that was specified in the quality management plan.

2- Verified Deliverables

- The results of performing the Control Quality process are verified deliverables that become an input to the Validate Scope process for formalized acceptance
- If there were any change requests or improvements related to the deliverables, they may be changed, inspected, and reverified.

3- Work Performance Information

- Information on project requirements fulfillment, causes for rejections, rework required, recommendations for corrective actions, lists of verified deliverables, status of the quality metrics, and the need for process adjustments.

4- Change Requests

5- Project Management Plan Updates

- Includes any change to project management plan like quality management plan

6- Project Documents Updates

- Includes (Issue log, Lessons learned register, Risk register and Test/evaluation documents)

Chapter 9 (Project Resource Management)

- Physical resources include equipment, materials, facilities, and infrastructure
- Human resources include Team resources or personnel
- The project manager is responsible for the team formation as an effective group
- The project manager as a leader should be responsible for proactively developing team skills and competencies while retaining and improving team satisfaction and motivation
- Modern project resource management approaches seek to optimize resource utilization
- Trends in resource management lean management, just in time (JIT), manufacturing, Kaizen, total productive maintenance (TPM), theory of constraints (TOC).
- Project manager should invest in personal emotional intelligence (EI) by improving inbound (self-management, self-awareness) and outbound (relationship management).
- Research suggests that project teams that succeed in developing team EI or become an emotionally competent group are more effective. Additionally, there is a reduction in staff turnover
- Agile approaches have improved self-organizing teams, where the team functions with an absence of centralized control.
- The globalization of projects has promoted the need for virtual teams that work on the same project, but are not collocated at the same site. The availability of communication technology has made virtual teams feasible
- Collaboration is intended to boost productivity and facilitate innovative problem solving
- Projects with high variability benefit from team structures that maximize focus and collaboration
- Planning for physical and human resources is much less predictable in projects with high variability

Plan Resource Management (Planning Process Group)

Plan Resource Management is the process of defining how to estimate, acquire, manage, and use team and physical resources.

Key benefit of this process is that it establishes the approach and level of management effort needed for managing project resources based on the type and complexity of the project.

- This process is performed once or at predefined points in the project.
- Resource planning is used to determine and identify an approach to ensure that sufficient resources are available for the successful completion of the project
- Project resources include team members, supplies, materials, equipment, services and facilities
- resources can be obtained from the organization's **internal** assets or from **outside** the organization through a **procurement** process.
- Other projects may be competing for the same resources required for the project at the same time and location which may impact project costs, schedules, risk and quality.

Plan Resource Management Inputs:

1- Project Charter

2- Project Management plan

- Includes (Quality management plan and Scope baseline)

3- Project Documents

- Includes (Project schedule, Requirements documentation, Risk register and Stakeholder register)

4- Enterprise Environmental Factors

5- Organizational Process Assets

Plan Resource Management Tools & Techniques:

1- Expert Judgment

2- Data Representation

- Includes Charts (Hierarchical, Matrix and text oriented).
- The Objective is to ensure that each work package has an unambiguous owner and that all team members have a clear understanding of their roles and responsibilities

- Hierarchical format may be used to represent high-level roles, while a text-based format may be better suited to document the detailed responsibilities

❖ **Hierarchical charts:** The traditional organizational chart structure can be used to show positions and relationships in a graphical, top-down format.

- **Work breakdown structure (WBS):** designed to show how project **deliverables** are broken down into work packages and provide a way of showing high-level areas of responsibility.
- **Organizational breakdown structure (OBS):** is arranged according to an organization's existing departments, units, or teams, with the project activities or work packages listed under each department. You **may see all project responsibilities** by looking at OBS
- **Resource breakdown structure:** hierarchical list of **team** and **physical** resources related by category and resource type that is used for planning, managing and controlling project. Each descending (lower) level represents an increasingly detailed description of the resource until the information is small enough to be used in conjunction with the work breakdown structure (WBS) to allow the work to be planned, monitored, and controlled.

❖ **Assignment Matrix:**

- Responsibility Assignment Matrix (**RAM**) shows the project **resources assigned** to **each work package**. It is used to illustrate the connections between work packages, or activities, and project team members
- On larger projects, RAMs can be developed at various levels (High and Low)
- High-level RAM can define the responsibilities of a project team, group, or unit within each component of the WBS
- Lower-level RAMs are used within the group to designate roles, responsibilities, and levels of authority for specific activities
- Matrix shows all activities associated with one person and all people associated with one activity. To ensure that there is only one person assigned to one task to avoid confusion
- Example of RAM is a RACI (responsible, accountable, consult and inform) chart
- RACI chart is a useful tool to use to ensure clear assignment of roles and responsibilities when the team consists of internal and external resources

RACI Chart	**Person**			
Activity	Ann	Diana	Sam	Ed
Create Charter	A	R	I	I
Collect requirements	I	A	R	C
Submit change request	I	A	R	R
Develop test plan	A	C	I	i

Sample RACI Chart

- **Text-oriented Formats:** Team member responsibilities that require **detailed descriptions** can be specified in text-oriented formats. Document provides information like **responsibilities, authority, competencies, and qualifications**. This document may be called (position description and role-responsibility) and it may be used as template for future projects.

3- Organizational theory

- Provides information regarding the way in which people, teams, and organizational units **behave**.
- Effective use of common techniques identified in organizational theory can **shorten** the amount of time, cost and effort needed to create the Plan Resource Management process outputs and improve planning efficiency

4- Meetings

Plan Resource Management Outputs:

1- Resource Management Plan

- provides guidance on how project resources should be categorized, allocated, managed, and released. It may be divided between the **team** management plan and **physical** resource management plan according to the specifics of the project. This include
- Resource Identification: Includes methods for identifying and quantifying team and physical resources needed
- Acquire resources: Includes guidance how to acquire team and physical resources
- Includes Roles and responsibilities such as
    - Role: function assumed by, or assigned to, a person in the project
    - Authority: The rights to apply project resources, make decisions, sign approvals, accept deliverables, and influence others to carry out project work
    - Responsibility: assigned duties and work that a project team member is expected to perform in order to complete the project's activities
    - Competence: skill and capacity required to complete assigned activities within the project constraints. If project member doesn't have required competencies, proactive response such as training, hiring, schedule changes, or scope changes are initiated.
- Project organization charts: graphic display **of project team members and their reporting** relationships. It can be formal or informal based on the need of the project
- Project team resource management: Guidance on how project team resources should be defined, staffed, managed, and eventually released
- Training: Training strategies for team members
- Team development: Methods for developing the project team.

- Resource control: Methods for ensuring adequate physical resources are available as needed and that the acquisition of physical resources is optimized for project needs.
- Recognition plan: Which recognition and rewards will be given to team members and when,

2- Team Charter

- Document that establishes the team values, agreements, and operating guidelines for the team
- Includes (Team values, Communication guidelines, Decision-making criteria and process, Conflict resolution process, meeting guidelines and Team agreements)
- Establishes clear expectations regarding **acceptable behavior by project team members** (Ground Rules)
- Early commitment to clear guidelines decreases misunderstandings and increases productivity
- Team charter works best when the team develops it, or at least has an opportunity to contribute to it
- Team charter can be reviewed and updated periodically

3- Project Document Updates

- Includes (Assumption log and Risk register)

Estimate Activity Resources (Planning Process Group)

Estimate Activity Resources is the process of estimating team resources and the type and quantities of materials, equipment, and supplies necessary to perform project work.

Key benefit of this process is that it identifies the type, quantity, and characteristics of resources required to complete the project.

- This process is performed **periodically** throughout the project as needed
- The Estimate Activity Resources process is closely coordinated with other processes, such as the Estimate Costs

Estimate Activity Resources Inputs:

1- Project Management plan

- Includes (Resource management plan and Scope baseline)

2- Project Documents

- Includes (Activity attributes, Activity list, Assumption log, Cost estimates, Resource calendars and Risk register)

3- Enterprise Environmental Factors

4- Organizational Process Assets

Estimate Activity Resources Tools & Techniques:

1- Expert Judgment

- Specialized knowledge or training in team and physical resource planning and estimating

2- Bottom-Up Estimating

- Team and physical resources are estimated at the activity level and then aggregated to develop the estimates for work packages, control accounts, and summary project levels

3- Analogous Estimating

- Uses information regarding resources from a previous similar project as the basis for estimating a future projects. It is used as **quick** estimating method and can be used when the project manager can only identify a few top levels of the WBS

4- Parametric Estimating

- Uses an algorithm or a statistical relationship between historical data and other variables to calculate resource quantities needed for an activity.

5- Data Analysis

- **Alternative analysis**: used to evaluate identified options in order to select the options or approaches to use to execute and perform the work of the project. Alternatives analysis assists in providing the best solution to perform the project activities, within the defined constraints

6- Project Management Information System (PMIS)

- Includes resource management software that can help plan, organize, and manage resource

7- Meetings

- The project manager may hold planning meetings with functional managers to estimate the resources needed per activity, level of effort (LoE), skill level of the team resources, and the quantity of the materials needed

Estimate Activity Resources Outputs:

1- Resources Requirements

- Identify the types and quantities of resources required for each work package or activity
- can be aggregated to determine the estimated resources for each work package, each WBS branch, and the project as a whole.

2- Basis of Estimates

- The amount and type of additional details supporting the resource estimate vary by application area
- It provides a clear and complete understanding of how the resource estimate was derived.

3- Resource Breakdown Structure

- Hierarchical representation of resources by category and type
- Categories include labor, material, equipment, and supplies.
- Resource types may include the skill level, grade level, required certifications
- It is used to guide the categorization for the project. In this process it is a completed document that will be used to acquire and monitor resources.

4- Project Documents Updates

- Includes (Activity attributes, Assumption log and Lessons learned register)

Acquire Resources (Executing Process Group)

Acquire Resources is the process of obtaining team members, facilities, equipment, materials, supplies, and other resources necessary to complete project work

Key benefit of this process is that it outlines and guides the selection of resources and assigns them to their respective activities.

- This process is performed **periodically** throughout the project as needed
- Resources can be internal or external
- Internal resources are acquired (assigned) from **functional or resource managers**
- External resources are acquired through the **procurement** processes.
- The project management team may or may not have direct control over resource
- The project manager or project team should effectively negotiate and influence others who are in a position to provide the required team and physical resources for the project.
- Failure to acquire the necessary resources for the project affect project schedules, budgets, customer satisfaction, and risks and it decreases the probability of success or result in cancellation
- If the team resources are not available due to constraints such as economic factors or assignment to other projects, the project manager or team may be required to assign alternative resources, perhaps with different competencies or costs. Alternative resources are allowed provided there is no violation of legal, regulatory, mandatory, or other specific criteria
- These factors should be considered and accounted for in the planning stages of the project

Acquire Resources Inputs:

1- Project Management Plan

- Includes (Resource management plan, Procurement management plan and Cost baseline)

2- Project Documents

- Includes (Project schedule, Resource calendars, Resource requirements and Stakeholder register)

3- Enterprise Environmental Factors

4- Organizational Process Assets

Acquire Resources Tools & Techniques:

1- Decision Making

- **Multicriteria decision:** criteria are developed and used to rate or score potential resources. The criteria are weighted according to their relative importance and values can be changed for different types of resources.
  Examples of selection criteria for resources includes (Availability, Cost, Team ability, Experience, Knowledge, Skills, Attitude and international factors).

2- Interpersonal and Team Skills

- **Negotiation**: Many projects need to negotiate for required resources. The team ability to influence others is an important role in negotiating resource allocation. The project management team may need to negotiate with
  - **Functional Manager:** Ensure that the project receives the best resources possible in the required timeframe and until their responsibilities are complete
  - **Other project management teams within the performing organization**
  - **External organizations and suppliers:** Provide appropriate, scarce, specialized, qualified, certified, or other specific team or physical resources.

3- Pre-Assignment

- When physical or team resources **are determined in advance**, they are considered pre-assigned
- This occur if the project is the result of specific resources being identified as part of a competitive proposal or if the project is dependent upon the expertise of particular persons
- Pre-assignment might also include the team members who have already been assigned in Develop Project Charter Process or other processes before the initial Resource Plan has been completed

4- Virtual Teams

- The use of virtual teams creates new possibilities when acquiring project team members
- Virtual teams are defined as groups of people with a shared goal who fulfill their roles with little or no time spent meeting face to face
- The availability of communication technology has made virtual teams feasible
- Communication planning becomes increasingly important in a virtual team environment

Acquire Resources Outputs:

1- Physical Resources Assignments

- Documentation of the physical resource assignments records the material, equipment, supplies, locations, and other physical resources that will be used during the project.

2- Project Team Assignments

- Documentation of team assignments records the team members and their roles and responsibilities for the project. Documentation can include a project team directory and names inserted into the project management plan, such as the project organization charts and schedules

3- Resource Calendars

- Identifies the working days, shifts, start and end of normal business hours, weekends, and public holidays when each specific resource is available
- Information on which **resour ces** are potentially **available during a planned activity** period is used for estimating resource utilization
- Resource calendars also specify **when** and for **how long** identified team and physical resources will be available during the project
- The information may be at the activity or project level

4- Change Requests

5- Project Management Plan Updates

- Includes (Resource management plan, Cost baseline)

6- Project Documents Updates

- Includes (Lessons learned register, Project schedule, Resource breakdown structure, Resource requirements, Risk register and Stakeholder register)

7- Enterprise Environmental Factors Updates

- Includes (Resource availability and Amount of the organization’s consumable resources used)

8- Organizational Process Assets Updates

- Includes (documentation related to acquiring, assigning and allocating resources)

Develop Team (Executing Process Group)

Develop Team is the process of improving competencies, team member interaction, and the overall team environment to enhance project performance

Key benefit of this process is that it results in improved teamwork, enhanced interpersonal skills and competencies, motivated employees, reduced attrition, and improved overall project performance.

- This process is performed throughout the project
- Project managers require skills to identify, build, maintain, motivate, lead, and inspire project teams to achieve high team performance and meet the project's objectives
- Teamwork is a critical factor for project success, and developing and effective team is the project manager's responsibility
- In a climate of mutual trust. Developing the project team improves the people skills, technical competencies, and overall team environment and project performance
- Objective of developing a project team include (Improve the team knowledge and skill to achieve project's objective and lower cost and reduce time, improve trust among the team to raise morale and lower conflict, create dynamic collaborative team to improve productivity and allow cross-training to share knowledge and expertise and empower decision making)
- One of the models to describe team development is "**Tuckman ladder**" which includes five stages of development the team may go through. Projects with team members who worked together in the past may skip a stage
    - **Forming**: a phase where the team members meet and learn about the project and their formal roles. Team members tend to be independent and not as open in this phase
    - **Storming:** the team begins to address the project work, technical decisions, and the project management approach. If team members are not collaborative or open to differing ideas and perspectives, the environment can become counterproductive
    - **Norming:** team members begin to work together and adjust their work habits and behaviors to support the team. The team members learn to trust each other
    - **Performing:** Teams that reach the performing stage function as a well-organized unit. They are interdependent and work through issues smoothly and effectively
    - **Adjourning:** the team completes the work and moves on from the project. This typically occurs when staff is released from the project as deliverables are completed or as part of the Close Project or Phase process
- The duration of a particular stage depends upon team dynamics, team size, and team leadership

Develop Team Inputs:

1- Project Management Plan

- Includes (Resource management plan)

2- Project Documents

- Includes (Lessons learned register, Project schedule, Project team assignments, Resource calendars and Team charter)

3- Enterprise Environmental Factors

4- Organizational Process Assets

Develop Team Tools & Techniques:

1- Colocation

- Colocation involves placing many or all of the most active project team members in the **same physical location** to enhance their ability to perform as a team
- Colocation can be temporary or can continue for the entire project
- Colocation strategies can include a team meeting room or common places to post schedules

2- Virtual Teams

- Virtual teams can bring benefits such as the use of more skilled resources, reduced costs, less travel and relocation expenses

3- Communication Technology

- Address team development issues in collocated and virtual teams and help in building harmonious environment for the collocated team and a better understanding for the virtual team
- Examples of communication technology (Shared portal (shared repository like websites or intranet which is effective for virtual teams), Video conferencing, Audio conferencing and Email/Chat.

4- Interpersonal and Team Skills

- **Conflict management:** The project manager needs to resolve conflicts in a timely manner and in a constructive way in order to achieve a high-performing team
- **Influencing:** An influencing skill used in this process is gathering relevant and critical information to address important issues and reach agreements while maintaining mutual trust.
- **Motivation:** Providing a reason for someone to act. Teams are motivated by empowering them to participate in decision making and encouraging them to work independently

- **Negotiation:** Negotiation among team members is used to reach consensus on project needs. Negotiation can build trust and harmony among the team members
- **Team Building**

❖ Team building is conducting activities that enhance the team's social relations and build collaborative approach and cooperative working environment

❖ Team building activities can vary from a 5-minute agenda item in a status review meeting to an offsite, professionally facilitated event

❖ Objective of team-building activities is to help individual team members **work together effectively.**

❖ While team building is essential during the initial stages of a project, it should be a continuous process. Changes in a project environment are inevitable, and to manage them effectively, a continuous or renewed team-building effort may be applied

❖ The project manager should continually monitor team functionality and performance to determine if any actions are needed to prevent or correct various team problems

5- Recognition and Rewards

- Part of the team development process involves recognizing and rewarding desirable behavior
- The original plan for rewarding people is developed during the Plan Resource Management process
- Reward decisions are made, formally or informally during the process of managing the project team
- Money is viewed as a tangible aspect of any reward system, but intangible rewards could be equally or even more effective
- Good strategy for project managers is to give the team recognition **throughout the life cycle**

6- Training

- Training includes all activities designed to enhance the competencies of the project team members
- Examples of training include classroom, online, computer-based, training from another project team
- Scheduled training takes place as stated in the resource management plan
- Unplanned training takes place as a result of observation, conversation, and project performance
- Training costs could be included in the project budget or supported by the performing organization if the added skills may be useful for future projects
- It may be performed by in-house or by external trainers.

7- Individual and Team Assessments

- Gives the project manager and the project team insight into areas of **strengths and weaknesses**
- Helps project managers assess team members' preferences, aspirations and how they process
- Various tools can be used such as attitudinal surveys, specific assessments, structured interviews, ability tests, and focus groups

8- Meetings

- Example: project orientation meetings, team-building meetings and team developments meetings

Develop Team Outputs:

1- Team Performance Assessments

- As project team development efforts such as training, team building, and colocation are implemented, the project management team makes formal or informal assessments of the project team's effectiveness.
- Effective team development strategies are expected to increase the team's performance, which increases the likelihood of meeting the project objectives.
- As a result of conducting evaluation of the team's overall performance, the project team can identify the specific training, coaching or changes required to improve the team performance

2- Change Requests

3- Project Management Plan Updates

- Includes (resource management plan)

4- Project Document Updates

- Includes (Lessons learned register, Project schedule, Project team assignments, Resource calendars and Team charter)

5- Enterprise Environmental Factors Updates

- Includes (Employee development plan record and skill assessments)

6- Organizational Process Assets Updates

- Includes (Training requirements and Personnel assessment)

Manage Team (Executing Process Group)

Manage Team is the process of tracking team member performance, providing feedback, resolving issues, and managing team changes to optimize project performance

Key benefit of this process is that it influences team behavior, manages conflict, and resolves issues.

- This process is performed throughout the project
- Team management involves a combination of skills with special emphasis on communication, conflict management, negotiation, and leadership
- Project managers should provide challenging assignments to team members and provide recognition for high performance
- The project manager needs to be sensitive to both the willingness and the ability of team members to perform their work and adjust their management and leadership styles accordingly

Manage Team Inputs:

1- Project Management Plan

- Includes (Resource management plan)

2- Project Documents

- Includes (Issue log, Lessons learned register, Project team assignments and Team charter)

3- Work Performance Reports

- Physical or electronic representation of work performance information intended to generate decisions, actions, or awareness.
- Project reports that can help with team management include results from (Schedule control, Cost control, Quality control and scope validation)
- The information in the reports assists in determining future team resource requirements, recognition and rewards and update the resource management plan

4- Team Performance Assessments

- Formal or informal assessments of the project team performance. Which helps in resolving issues, modify communication address conflict and improve the team interaction

5- Enterprise Environmental Factors

6- Organizational Process Assets

Manage Team Tools & Techniques:

1- Interpersonal and Team Skills

- **Conflict management**

❖ Conflict is inevitable in a project environment. Sources of conflict include scarce resources, scheduling priorities, and personal work styles

❖ Team ground rules, group norms, and solid project management practices, like communication planning and role definition, **reduce** the amount of conflict

❖ Successful conflict management results in greater productivity and positive working relationships. When managed, differences of opinion can lead to increased creativity and better decision making

❖ Conflict should be addressed early and usually in private, using a direct, collaborative approach. If disruptive conflict continues, formal procedures may be used, including disciplinary actions

❖ There are five general techniques in resolving the conflict

- **Withdraw/avoid**: Retreating from an actual or potential conflict situation; **postponing** the issue to be better prepared or to be resolved by others
- **Smooth/accommodate** Emphasizing areas of **agreement** rather than areas of difference; conceding one's position to the needs of others to maintain harmony and relationships.
- **Compromise/reconcile**: Searching for solutions that bring **some degree of satisfaction to all** parties in order to temporarily or partially resolve the conflict. This approach occasionally results in a **lose-lose situation.**
- **Force/direct:** Pushing one's viewpoint at the expense of others; offering only win-lose solutions, usually enforced through a power position to resolve an emergency. This approach often results to a **win-lose situation**
- **Collaborate/problem solve**: Incorporating multiple viewpoints and insights from differing perspectives, requires a cooperative attitude and open dialogue that typically leads to consensus and commitment. This approach can result in a **win-win situation.**

- **Decision making:** Ability to negotiate and influence the organization and the project management team, rather than the set of tools described in the decision making tool set

- **Emotional Intelligence:** Ability to identify, assess, and manage the personal emotions of oneself and other people. The team may use it to reduce tension and increase cooperation by identifying, assessing, and controlling the sentiments of project team members and follow up on their issues.

- **Influencing:** Because project managers often have little or no direct authority over team members in a matrix environment, their ability to influence stakeholders on a timely basis is critical to project success. Key skills include (Ability to be persuasive, Articulate points and positions, Effective listening skills, Awareness in any situation and Gather information to address issues)

- **Leadership:** Successful projects require leaders with strong leadership skills. Leadership is the ability to lead a team and inspire them to do their jobs well. It encompasses a wide range of skills, abilities and actions. Leadership is important through all phases of the project life cycle.

2- Project Management Information System (PMIS)

- Includes (resource management scheduling software that can be used to managing and coordinating team members across the project activities)

Manage Team Outputs:

1- Change Requests

- Example (Staffing changes whether made by choice or by uncontrollable events, can disrupt the project team. This disruption can cause the schedule to slip or the budget to be exceeded. Staffing changes include moving people to different assignments, outsourcing some of the work, or replacing team members who leave)

2- Project Management Plan Updates

- Includes (Resource management plan, Schedule baseline, Cost baseline)

3- Project Documents Updates

- Includes (Issue log, Lessons learned register and Project team assignments)

4- Enterprise Environmental Factors Updates

- Includes (Input to organizational performance appraisals and Personnel skill)

Control Resources (Monitor & Controlling Process Group)

Control Resources is the process of ensuring that the physical resources assigned and allocated to the project are available as planned, as well as monitoring the planned versus actual utilization of resources and taking corrective action as necessary

Key benefit of this process is ensuring that the assigned resources are available to the project at the right time and in the right place and are released when no longer needed

- Control Resources process should be performed continuously in all project phases and throughout the project life cycle
- The resources needed for the project should be assigned and released at the right time, right place, and right amount for the project to continue without delays
- The Control Resources process is concerned with **physical resources** such as equipment, materials and facilities. Team members are addressed in the **Manage Team** process.
- Updating resource allocation requires knowing what actual resources have been used to date and what is still needed

Control Resources Inputs:

1- Project Management Plan

- Includes (Resource management plan)

2- Project Documents

- Includes (Issue log, Lessons learned register and physical resource assignments, Project schedule, Resource breakdown structure, Resource requirements and Risk register)

3- Work Performance Data

- Contains data on project status such as the number and type of resources that have been used

4- Agreements

- Agreements made within the context of the project are the basis for all resources external to the organization and should define procedures when new, unplanned resources are needed or when issues arise with the current resources

5- Organizational Process Assets

Control Resources Tools & Techniques:

1- Data Analysis

- **Alternative analysis:** Alternatives can be analyzed to select the best resolution for correcting variances in resource utilization
- **Cost-benefit analysis:** helps to determine the **best corrective action** in terms of cost in case of project deviations
- **Performance reviews:** Performance reviews measure, compare, and analyze planned resource utilization to actual resource utilization. Cost and schedule work performance information can also be analyzed to help pinpoint issues that can influence resource utilization
- **Trend Analysis:** As the project progresses, the project team may use trend analysis, based on current performance information, to determine the resources needed at upcoming stages of the project. Trend analysis examines project performance over time and can be used to determine whether performance is **improving or deteriorating**.

2- Problem Solving

- Set of tools that helps the project manager to solve problems during the control resource process
- The problem can be inside or outside the organization
- The methodical steps to deal with a problem include (Identify the problem, Define the problem, Investigate, Analyze, Solve and Check the solution)

3- Interpersonal and Team Skills (Soft Skills)

- **Negotiation:** Project manager may need to negotiate for additional physical resources, changes in physical resources, or costs associated with the resources.
- **Influencing:** Influencing can help the project manager solve problems and obtain the resources needed in a timely manner

4- Project Management Information System (PMIS)

- Includes resource management scheduling software that can be used to monitor resource utilization

Control Resources Outputs:

1- Work Performance Information

- includes information on how the project work is progressing by comparing resource requirements and resource allocation to resource utilization across the project activities.
- This comparison can show gaps in resource availability that need to be addressed

2- Change Requests

3- Project Management Plan Updates

- Includes (Resource management plan, Scheduling baseline and Cost baseline)

4- Project Documents Updates

- Includes (Assumption log, Issue log, Lessons learned register, Physical resource assignments, Resource breakdown structure and Risk register)

Chapter 10 (Project Communication Management)

- Project Communications Management consists of two parts. The first part is developing a strategy to ensure communication is effective for stakeholders. The second part is carrying out the activities necessary to implement the communication strategy
- Communication is the exchange of information, intended or involuntary. The information exchanged can be in the form of ideas, instructions, or emotions. The mechanisms by which information is exchanged can be in (Written form, Spoken, Formal/Informal, Through gestures, Through media and Choice of words)
- Information can be sent or received, either through communication activities or project documents
- Communication activities have many dimensions, including
    - ❖ Internal: Focus on stakeholders within the project and organization
    - ❖ External: Focus on external stakeholders (customers, vendors, government)
    - ❖ Formal: Reports, formal meeting, presentation or stakeholder briefings
    - ❖ Informal: General communication through email, social media, websites
    - ❖ Hierarchical focus: The position of the stakeholder or group with respect to the project team will affect the format and content of the message (Upward: Senior management stakeholders, Downward: team others who contribute project work and Horizontal: peers of the project manager or team
    - ❖ Official: Annual reports, reports to regulators or government bodies
    - ❖ Unofficial: Communications that focus on establishing and maintaining the profile and recognition of the project and building strong relationships between the project team and its stakeholders using flexible and often informal means.
    - ❖ Written and oral: Can be verbal and nonverbal (body language), social media and websites
- The act of sending and receiving information takes place consciously or unconsciously
- There are two parts to successful communication. First part involves developing an appropriate communication strategy based on both the needs of the project and the project stakeholders. From that strategy, a communications management plan is developed
- Project communications are the products of the planning process, addressed by the communications management plan
- Project communications are supported to prevent misunderstandings and miscommunication
- Misunderstandings can be reduced using the 5C' (Correct grammar and spelling, Concise expression and elimination for excess words, Clear purpose and expression, Coherent logical flow of ideas and Controlling flow of words and ideas)
- The 5c's are supported by communication skills like (Listening actively, Awareness of cultural and personal differences, Identifying and managing stakeholder expectations and Enhancement of skills
- Trends and practices in project communication management include (Inclusion of stakeholders in project reviews, Inclusion of stakeholder in project meetings, Increased use of social computing, Multifaceted approached to communication

Plan Communications Management (Planning Process Group)

Plan Communications Management is the process of developing an appropriate approach and plan for project communications activities based on the information needs of each stakeholder or group, available organizational assets, and the needs of the project

Key benefit of this process is a documented approach to effectively and efficiently engage stakeholders by presenting relevant information in a timely manner

- This process is performed periodically throughout the project as needed
- An effective communications management plan is developed early in project life cycle
- It should be reviewed regularly and modified when necessary when the stakeholder community changes or at the start of each new project phase.
- On most projects, communications planning is performed very early, during stakeholder identification and project management plan development.

Plan Communications Management Inputs: (No Project Charter)

1- Project Management Plan

- Includes (Resource management plan and Stakeholder engagement plan)

2- Project Documents

- Includes (Requirements documentation and Stakeholder register)

3- Enterprise Environmental Factors

4- Organizational Process Assets

Plan Communications Management Tools & Techniques:

1- Expert Judgment

2- Communication Requirements Analysis

- Analysis of communication requirements determines the information needs of the project stakeholders. These requirements are defined by combining the type and format of information needed with an analysis of the value of that information

- Sources of information include (Stakeholder information, Number of potential communication channels, Organizational charts, Development approach, Internal and external information and Legal requirements)

3- Communication Technology

- Methods includes (Conversation, meetings, Written documents, Databases and Websites)
- Factors that affect the choice of communication include (Urgency of the need for information, Availability and reliability of technology, Ease of use, Project environment (face-to-face or virtual) and Sensitivity and confidentiality of the information)

4- Communication Models

- Represent the communication process in its most basic linear form (sender and receiver), in more interactive form (sender, receiver, feedback) or in complex model that incorporates the human elements of the sender(s) or receiver(s) and attempts to show the complexity of any communication that involves people
- **Sample basic sender/receiver communication model:** This model consists two parties (sender and receiver). This model is concerned with ensuring that message is **delivered**, **rather than understood.** The sequence of steps in basic communication model is
    - **Encode**: The message is coded into symbols, such as text, sound or some other **medium**
    - **Transmit message**: The message is sent via a communication channel. The transmission of this message may be compromised by various physical factors (unfamiliar technology) or inadequate infrastructure. **Noise** may result in loss of information in transmission/reception
    - **Decode**: Data received is translated by the receiver back into a form useful to the receiver

- **Sample Interactive communication model:** This model consists two parties (sender and receiver), but recognizes the need to ensure the message has been **understood**. Noise includes any interference or barriers that might compromise the understanding of the message such as (receiver distraction, lack of knowledge or variations in the perceptions of receivers). Steps in this model
    - **Acknowledge:** Upon receipt of a message, the receiver may signal (acknowledge) receipt of the message, but this does not necessarily mean agreement with or comprehension of the message—merely that it has been received.
    - **Feedback/response:** When the received message has been decoded and understood, the receiver encodes thoughts and ideas into a message and then transmits this message to the original sender. If the sender perceives that the feedback matches the original message, the communication has been successful. Feedback can be achieved through **active listening**

- The sender is **responsible** for the transmission of the message, ensuring the information being communicated is clear and complete and confirm the message is correctly interpreted.
- The receiver is **responsible** for ensuring that the information is received in its entirety, interpreted correctly and acknowledged or responded to appropriately

- Cross-cultural communication presents challenges to ensuring that the meaning of the message has been understood.

5- Communication Methods

- **Interactive communication:** Between two or more parties performing a multidirectional exchange of information in **real time** like (Meetings, phone calls, video conferencing and instant messaging)
- **Push communication:** Sent or distributed directly to specific recipients who need to receive the information. This ensures that the information is **distributed** but does not ensure that it actually reached or was understood. Like (letters, memos, reports, **emails**, faxes, **voicemail** and blogs)
- **Pull communication:** Used for large complex information sets, or for large audiences, and requires the **recipients to access** content at their own discretion subject to security procedure. Like (web **portals**, intranet sites, e-learning, lessons learned databases or knowledge repositories)
- Different approaches should be applied to meet the needs of the major forms of communication
    - ❖ Interpersonal communication: Information is exchanged between individuals, typically face-to-face.
    - ❖ Small group communication: Occurs within groups of around three to six people
    - ❖ Public communication: A single speaker addressing a group of people
    - ❖ Mass communication: There is a minimal connection between the person or group sending the message and the large, sometimes anonymous groups for whom the information is intended
    - ❖ Networks and social computing communication: Supports emerging communication trends of many-to-many supported by social computing technology and media

6- Interpersonal and Team Skills

- **Communication style assessment:** A technique used to assess communication styles and identify the **preferred** communication method for planned communication activities. Often used with **unsupportive stakeholders,** this assessment may follow stakeholder engagement assessment to identify gaps in stakeholder engagement plan
- **Political awareness:** Helps the project manager to plan communications based on the project environment as well as organization's political environment. Political awareness concerns the recognition of power relationships, both formal and informal and also the willingness to operate within these structures. This help communicate with stakeholders in aspect of political awareness.
- **Cultural awareness:** Understanding of the difference between individual and groups and adapting the project's communication strategy in the context of these differences. This minimize misunderstandings and miscommunications that may result in cultural differences

7- Data Representation

- **Stakeholder engagement assessment matrix:** displays gaps between current and desired engagement levels of individual stakeholders, it can be further analyzed in this process to identify additional communication requirements as a method to close any engagement level gaps

8- Meetings: include virtual (e-meetings) or face-to-face meetings, and can be supported with document collaboration technologies, including email messages and project websites.

Plan Communications Management Outputs:

1- Communication Management Plan

- The communications management plan is a component of the project management plan that describes how project communications will be planned, structured, implemented, and monitored for effectiveness.
- This communication management plan can include **guidelines** and templates for project status meetings, project team meetings, e-meetings, and email messages. The use of a project website and project management software can be included if these are to be used in the project
- It also contains "**Escalation processes**"

2- Project Management Plan Updates

- **Any** change to the project management plan goes through the organization's change control process via a change request. Example stakeholder engagement plan

3- Project Documents Updates

- Includes (Project schedule and Stakeholder register)

Manage Communications (Executing Process Group)

Manage Communications is the process of ensuring timely and appropriate collection, creation, distribution, storage, retrieval, management, monitoring, and the ultimate disposition of project information.

Key benefit of this process is that it enables an efficient and effective information flow between the project team and the stakeholders

- This process is performed throughout the project
- The Manage Communications process identifies all aspects of effective communication, including choice of appropriate technologies, methods, and techniques
- It should allow flexibility in the communication activities allowing adjustments in the methods and techniques to accommodate the changing needs of stakeholders and the project.
- This process ensure that the information has been generated is appropriately generated and formatted and received by the intended audience. Also provides opportunities for stakeholders to make requests for further information and clarification
- Techniques for effective communication management includes (Sender-receiver models, choice of media, writing style, meeting management, presentations, facilitation and Active listening)

Manage Communication Inputs

1- Project Management Plan

- Includes (Resource management plan, communications management plan and stakeholder engagement plan)

2- Project Documents

- Includes (Change log, Issue log, lessons learned register, Risk report and Stakeholder register)

3- Work Performance Reports

- Reports are circulated to the project stakeholders through this process
- Example of reports (status and progress reports)
- Work performance reports can contain earned value graphs and information, trend lines and forecasts, defect histograms, contract performance information, and risk summaries
- They can be presented as dashboards, heat reports, stop light charts, or other representations useful for creating awareness and generating decisions and actions

4- Enterprise Environmental Factors

5- Organizational Process Assets

Manage Communication Tools & Techniques:

1- Communication Technology

- Factors that influence the technology includes weather team is collocated, information confidentiality, resource availability and organization culture

2- Communication Methods

3- Communication Skills

- **Communication competence:** A combination of tailored communication skills that considers factors such as clarity of purpose in key messages, effective relationships and information sharing, and leadership behaviors.
- **Feedback:** information about reactions to communications or a deliverable. Feedback supports interactive communication between the manager, team and stakeholders. Example (coaching, negotiating and mentoring)
- **Nonverbal:** Examples of nonverbal communication include appropriate body language to transmit meaning through gestures, tone of voice, and facial expressions, eye contact and Mirroring)
- **Presentation:** Formal delivery of information and/or documentation. Clear and effective presentations of project information to relevant stakeholders include (Progress reports, Background information, General information about the project and specific information on a subject)

4- Project Management Information System (PMIS)

- **Electronic project management tools:** Project management software, meeting and virtual office support software, web interfaces and work management tools
- **Electronic communications management:** Email, fax, and voice mail; audio, video and web conferencing; and websites and web publishing
- **Social media management:** Websites and web publishing; and blogs and applications, which offer the opportunity to engage with stakeholders and form online communities

5- Project Reporting

- Project reporting is the act of collecting and distributing project information
- Reporting format may range from a simple communication to more elaborate custom reports
- While work performance reports are the output of the Monitor and Control Project Work process, this process develops **ad hoc** reports, project presentations blogs

6- Interpersonal and Team Skills

- **Active Listening:** involve acknowledging, clarifying and confirming, understanding and removing barriers that adversely affect comprehension
- **Meeting management:** taking steps to ensure meetings meet their intended objectives effectively and efficiently

- **Networking:** interacting with others to exchange information and develop contacts. Networks provide the manager and the team access to **informal** organizations to solve problems, influence actions of their stakeholders, and increase stakeholder support for the work and outcomes.
- **Political awareness:** assists the project manager in engaging stakeholders appropriately to maintain their support throughout the project
- **Cultural awareness**
- **Conflict management**

7- Meetings

Manage Communication Outputs:

1- Project Communications

- Project communications artifacts includes: performance reports, deliverable status, schedule progress, cost incurred, presentations, and other information required by stakeholders

2- Project Management Plan Updates

- Includes (Communication management plan and Stakeholder engagement plan)

3- Project Documents Updates

- Includes (Issue log, Lessons learned register, Project schedule, Risk register and Stakeholder register)

4- Organizational Process Assets Updates

- Includes (Project records such as memos, meeting minutes and planned and ad hoc reports)

Monitor Communications (Monitor & Controlling Process Group)

Monitor Communications is the process of ensuring the information needs of the project and its stakeholders are met

Key benefit of this process is the optimal information flow as defined in the communications management plan and the stakeholder engagement plan.

- This process is performed throughout the project
- Monitor Communications determines if the planned communications had the desired effect of increasing or maintaining stakeholders. And ensure the information is delivered to the right audience through the right channel at the right time
- Monitor Communications process can trigger an iteration of the Plan Communications Management and/or Manage Communications processes to improve effectiveness of communication

Monitor Communication Inputs:

1- Project Management Plan

- Includes Resource management plan, Communications management plan and Stakeholders engagement plan

2- Project Documents

- Includes (Issue log, Lessons learned register and Project communications)

3- Work Performance Data

- contains data on the types and quantities of communications that have actually been distributed

4- Enterprise Environmental Factors

5- Organizational Process Assets

Monitor Communication Tools & Techniques:

1- Expert Judgment

- Specialized knowledge in communicating with the public and the media and in communications project management systems

2- Project Management Information System (PMIS)

- Tools for manager to capture and store information to internal and external stakeholders

3- Data Representation

- **Stakeholder engagement assessment matrix**: Provide information about the effectiveness of the communications. This is achieved by reviewing changes between desired and current engagement and adjusting communications as necessary

4- Interpersonal and Team Skills

- **Observation/Conversation:** Discussion and dialogue with the project team helps determine the most appropriate way to update and communicate project performance, and to respond to requests from stakeholders for information. Also help the manager to detect any conflicts between people

5- Meetings

- Meetings can be face-to-face or virtual to respond to stakeholder's requests and have discussions with suppliers and other project stakeholders

Monitor Communication Outputs:

1- Work Performance Information

- information on how project communication is performing by comparing the communications that were implemented compared to those that were planned. It is also considered feedback on communications such as survey results on communication effectiveness

2- Change Requests

- Change requests may result in (Revision of stakeholder communications requirements such as stakeholders and distribution and may add new procedures to eliminate bottlenecks)

3- Project Management Plan Updates

- Includes (Communications management plan and Stakeholder engagement plan)

4- Project Documents Updates

- Includes (Issue log, Lessons learned register and Stakeholder register)

Chapter 11 (Project Risk Management)

- Project Risk Management aims to identify and manage risks that are not addressed by the other project management processes. When unmanaged these risks can cause the project to deviate from the plan and fail to achieve its objectives.
- The effectiveness of Project Risk Management is directly related to project success.
- Risk exists at two levels (**Individual** risks and **Overall** risks)
- Individual risks an uncertain event or condition that, if it occurs, has a **positive** or **negative** effect on one or more project objectives
- Overall project risk the effect of uncertainty on the project as a whole, arising from all sources of uncertainty including individual risks, representing the exposure of stakeholders to the implications of variations in project outcome for both positive and negative risks
- Project risk management aims to enhance positive risks (opportunities) while avoiding or mitigating negative risks (threats)
- Unmanaged threats may result in issues or problems such as delay, cost overruns, performance shortfall loss of reputation. However, Opportunities that are captured can lead to benefits such as reduced time and cost, improved performance, or reputation.
- Project Risk Management processes should be conducted **iteratively**.
- Risk is initially addressed during project planning by shaping the project strategy
- project team needs to know what level of risk exposure is acceptable. This is defined by measurable **risk thresholds** that reflect the risk appetite
- Risk thresholds express the degree of acceptable variation around a project objective. They are explicitly stated and communicated to the project team and reflected in the definitions of risk impact levels for the project.
- Project Risk management includes (Non-event risks, Project resilience and integrated risks management)
- There are two main types of non-event risks (Variability risk and Ambiguity risk)
- **Variability** risk: Uncertainty exists about some key characteristics of a planned event or decision such as (productivity may be above or below target, or errors to be higher or lower than expected)
- **Ambiguity** risk: Uncertainty exists about what might happen in the future. Areas of the project where imperfect knowledge might affect the project's ability to achieve its objectives such as (requirements or technical solution, or future developments in regulator frameworks)
- **Variability** risks can be addressed using **Monte Carlo analysis**
- **Ambiguity** risks can be addressed using incremental development, **prototyping** and **simulation**
- Ambiguity risks can be managed by defining areas with deficit of knowledge or understanding and filling up the gap by obtaining expert external input or benchmarking
- Project resilience: The existence of emergent risk is becoming clear, with a growing awareness of unkown-unkowns

- Emergent risks can be tackled through developing **project resilience** which requires the project to have (Right level of budget and schedule contingency, Flexible project processes, Empowered project team, Frequent review of early warning and clear input from stakeholders)
- Integrated risk management: Projects exist in an organizational context, and they may form part of a program or portfolio. Risk exists at each of these levels, and risks should be owned and managed at the appropriate level.
- In agile/adaptive environments frequent reviews are used of incremental work products and cross-functional project team to accelerate knowledge sharing and ensure risk is managed
- requirements are kept as a living document that is updated regularly, and work may be reprioritized as the project progresses, based on an improved understanding of current risk exposure.

Plan Risk Management (Planning Process Group)

Plan Risk Management is the process of defining how to conduct risk management activities for a project

Key benefit of this process is that it ensures that the degree, type, and visibility of risk management are proportionate to both risks and the importance of the project to the organization and other stakeholders

- This process is performed once or at predefined points in the project
- The Plan Risk Management process should begin when a project is conceived and should be completed early in the project.

Plan Risk Management Inputs:

1- Project Charter

2- Project Management Plan

- All subsidiary management plans should be taken in consideration in order to make the risk management plan

3- Enterprise Environmental Factors

4- Organizational Process Assets

Plan Risk Management Tools & Techniques:

1- Expert Judgment

2- Data Analysis

- Stakeholder analysis: to determine the risk appetite of project stakeholders

3- Meetings

- The risk management plan may be developed as part of the project kick-off meeting or a specific planning meeting may be held
- Attendees may include project manager, project team, key stakeholders and some from outside the organization such as customers and sellers
- Skilled facilitator can help remain focused on the tasks
- Plans for conducting risk management activities are defined in these meetings and documented in the risk management plan

Plan Risk Management Outputs:

1- Risk Management Plan

- risk management plan is a component of the project management plan that describes how risk management activities will be structured and performed. It may include the following elements
- **Risk Strategy:** Describes the general approach to managing risk on this project.
- **Methodology:** Defines the specific approaches, tools, and data sources that will be used
- **Role and responsibilities:** Defines the lead, support, and risk management team members for each type of activity described in the risk management plan, and clarifies their responsibilities
- **Funding:** Identifies the funds needed to perform activities related to Project Risk Management. Establishes protocols for the application of contingency and management reserves
- **Timing:** Defines when and how often the Project Risk Management processes will be performed throughout the project life cycle, and establishes risk management activities for inclusion into the project schedule.
- **Risk categories:** Provide a means for grouping individual project risks. A common way to structure risk categories is with a risk breakdown structure (**RBS**). Which hierarchical representation of potential sources of risk. RBS helps team to consider the full range of risk sources which will be useful when identify and categorize risks. When RBS is not used the organization may use a custom risk categorization framework which is a simple list of categories or structure
- **Stakeholder risk appetite:** Stakeholder risk appetite should be expressed as measurable risk thresholds around each project objective. These thresholds will determine the acceptable level of overall project risk exposure and inform the definitions of probability and impacts when assessing and prioritizing risks.
- **Definitions of risk probability and impacts:** Definitions of risk probability and impact levels are specific to the project context and reflect the risk appetite and thresholds of the organization and key stakeholders. The number of levels reflects the degree of detail required for the Project Risk Management process with more levels used for more detailed risk approach (typically five levels) and fewer for simple process (usually there)
- **Probability and impact Matrix:** Opportunities and threats are represented in a common probability and impact matrix using positive definitions of impact for opportunities and negative impact definitions for threats. Descriptive terms (High, medium, low) or numeric values can be used for probability and impact. When numeric values are used, these can be multiplied to give a probability-impact score for each risk, which allows the relative priority of individual risks to be evaluated within each priority level
- **Reporting formats:** Define how the outcomes of the Project Risk Management process will be documented, analyzed, and communicated. It describes the content and format of the risk register and the risk report, and any other required outputs from the Project Risk Management processes
- **Tracking:** Tracking documents how risk activities will be recorded and how risk management processes will be audited.

Identify Risk (Planning Process Group)

Identify Risks is the process of identifying individual project risks as well as sources of overall project risk, and documenting their characteristics

Key benefit of this process is the documentation of existing individual project risks and the sources of overall project risk. It also brings together information so the project team can respond appropriately to identified risks

- This process is performed throughout the project
- Identify Risks considers both individual project risks and sources of overall project risk
- All project stakeholders should be encouraged to identify individual project risks
- It's important to involve project team so they can develop and maintain sense of ownership and responsibility for identified individual risks and overall project risk
- **Risk owners** for individual project risks may be nominated as part of the Identify Risks process, and will be **confirmed** during the Perform **Qualitative Risk Analysis** process
- Identify Risks is an **iterative** process, since new individual project risks may emerge as the project progresses through its life cycle
- Preliminary risk responses may also be identified and recorded and will be reviewed and confirmed as part of the Plan Risk Responses process

Identify Risk Inputs:

1- Project Management Plan

- Includes (Requirements management plan, Schedule management plan, Cost management plan, Quality management plan, Resource management plan, Risk management plan, Scope baseline, Schedule baseline and Cost baseline)

2- Project Documents

- Includes (Assumption log, Cost estimates, Duration estimates, Issue log, Lessons learned register, Requirements documentation, Resource requirements and Stakeholder register)

3- Agreements

- agreements may have information such as milestone dates, contract type, acceptance criteria, and awards and penalties that can present threats or opportunities

4- Procurement Documentation

- If the project requires external procurement of resources, the initial procurement documentation should be reviewed as procuring goods and services from outside the organization may increase or decrease overall project risk and may introduce additional individual project risks. Examples (seller performance reports and approved change requests and information inspections

5- Enterprise Environmental Factors

6- Organizational Process Assets

<u>Identify Risk Tools & Techniques:</u>

1- Expert Judgment

2- Data Gathering

- **Brainstorming:** The goal of brainstorming to obtain a comprehensive list of individual project risks and sources of overall project risk. Ideas are generated under the guidance of facilitator. Categories of risk, such as in a risk breakdown structure, can be used as a framework
- **Checklists:** list of items, actions, or points to be considered. It is often used as a reminder. Risk checklists are developed based on historical information and knowledge that has been accumulated from similar projects. They are an effective way to **capture lessons learned** from similar projects. Checklists are quick and **simple** to use, but it is impossible to build exhaustive list. Checklists must be updated from time to time to update new information or remove expired information
- **Interviews:** Individual project risks and sources of overall project risk can be identified by interviewing experienced project participants

3- Data Analysis

- **Root cause analysis:** used to discover the underlying causes that lead to a problem, and develop **preventive action**. It can be used to identify problem statement and explore threats that might result from that problem. Also this technique can be used to **find opportunities** by starting with benefit statement and explore which opportunities might result in that benefit being realized.
- **Assumption and constraint analysis:** Assumption and constraint analysis explores the validity of assumptions and constraints to determine which pose a risk to the project. Threats may be identified from the inaccuracy, inconsistency, or incompleteness of assumptions. **Constraints** may give rise to **opportunities** through removing or relaxing a limiting factor that affects the execution of a project
- **SWOT analysis:** This technique examines the project from each of the strengths, weaknesses, opportunities and threats (SWOT) perspectives. It is used to increase the breadth of identified risks by **including internally generated risks**. Also examines the degree to which organizational strengths may offset threats and determines if weaknesses might hinder opportunities

- **Document analysis:** Risks may be identified from a structured review of project documents, including (assumptions, constraints, previous project files, contracts, agreements and technical documentation). Uncertainty or ambiguity in project documents, as well as inconsistencies within a document or between different documents, may be indicators of risk on the project

4- Interpersonal and Team skills

- **Facilitation:** improves the effectiveness of many of the techniques used to identify individual project risks and sources of overall project risk. A skilled facilitator can help participants remain focused

5- Prompt Lists

- **Predetermined list of risk categories** that might give rise to individual project risks and that could also act as sources of **overall** project risk
- Prompt list can be used as a **framework** to aid the project team in **idea generation** when using risk identification techniques
- The risk categories in the lowest level of the risk breakdown structure can be used as a prompt list for individual project risks
- PESTLE (Political, Economic, Social, Technological, Legal and Environmental), TECOP (Technical, Environmental, Commercial, Operational, Political) or VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) are common framework for identifying sources of overall project risk

6- Meetings

- Project team may conduct a specialized meeting (often called a **risk workshop**).
- Most risk workshops include some form of brainstorming, but other techniques for identification can be included depending on risk process in risk management plan
- In small project risk workshops maybe restricted to a subset of project team

Identify Risk Outputs:

1- Risk Register

- The risk register capture details of identified **individual** project risks
- The results of Perform Qualitative Risk Analysis, Plan Risk Responses, Implement Risk Responses, and Monitor Risks are recorded in the risk register
- Risk register includes (List of identified risks, Potential risk owner and List of potential risk responses)
- Other data may be included in risk register such as (short risk title, risk category and status, risk triggers, WBS reference and timing information

2- Risk Report

- The risk report presents information on sources of **overall** project risk, together with summary information on identified individual project risks
- Risk report is developed progressively throughout the Project Risk Management process
- results of Perform Qualitative Risk Analysis, Perform Quantitative Risk Analysis, Plan Risk Responses, Implement Risk Responses, and Monitor Risks are also included in the risk report
- Risk report includes
    - ❖ Sources of overall project risk indicating the most important drivers of overall project risk exposure
    - ❖ Summary information on identified project risks such as (Number of identified threats and opportunities, Categories, Metrics and Trends)

3- Project Document Updates

- Includes (Assumption log, Issue log and Lessons learned register)

Perform Qualitative Risk Analysis (Planning Process Group)

Perform Qualitative Risk Analysis is the process of prioritizing individual project risks for further analysis or action by assessing their probability of occurrence and impact as well as other characteristics

Key benefit of this process is that it focuses efforts on high-priority risks

- This process is performed throughout the project
- Perform Qualitative Risk Analysis assesses the priority of identified individual project risks using their probability of occurrence, and Impact on project objectives
- Effective assessment therefore requires explicit identification and management of the risk attitudes of key participants in the Perform Qualitative Risk Analysis process
- Risk perception introduces bias into the assessment of identified risks.
- Addressing bias is a key part of the facilitator's role if used
- Perform Qualitative Risk Analysis establishes the relative priorities of individual project risks for Plan Risk Responses, as it identifies a risk owner for each risk who will take responsibility for planning an appropriate risk response and ensuring that it is implemented
- Qualitative Risk Analysis also lays the foundation for Perform Quantitative Risk Analysis
- In agile development environment, the Perform Qualitative Risk Analysis process is conducted before the **start of each iteration**

Perform Qualitative Risk Analysis Inputs:

1- Project Management Plan

- Includes Risk management plan

2- Project Documents

- Includes (Assumption log, Risk register and Stakeholder register)

3- Enterprise Environmental Factors

4- Organizational Process Assets

Perform Qualitative Risk Analysis Tools & Techniques:

1- Expert Judgment

2- Data Gathering

- **Interviews:** Structured or semi-structured interviews can be used to assess the probability and impacts of individual project risks

3- Data Analysis

- **Risk data quality assessment:**

❖ Evaluates the degree to which the data about individual project risks is accurate and reliable as a basis for qualitative risk analysis.

❖ The use of low-quality risk data may lead to a qualitative risk analysis that is of little use to the project and if the data quality is unacceptable it is better to gather better data

❖ Risk data quality can be assessed via a **questionnaire** measuring project's stakeholder perceptions

❖ weighted average of selected data quality characteristics can then be generated to give an overall quality score

- **Risk probability and impact assessment:**

❖ Risk probability assessment considers the **likelihood** that a specific risk will occur.

❖ Risk impact assessment considers the potential effect on one or more project objectives such as schedule, cost, quality, or performance

❖ Impacts will be negative for threats and positive for opportunities

❖ Risks can be assessed in **interviews** or **meetings**

❖ Risks with low probability and impact may be included within the risk register as part of a watch list for future monitoring.

- **Assessment of other risk parameters:** The project team may consider other characteristics of risk, they include

❖ Urgency: time within which a response to the risk is to be implemented in order to be effective

❖ Proximity: time before the risk might have an impact on one objective. short period indicates high proximity

❖ Manageability: The ease with which the risk owner can manage the occurrence or impact of a risk. Where management is easy, manageability is high

❖ Controllability: degree to which the risk owner is able to control the risk's outcome. Where the outcome can be easily controlled, controllability is high

❖ Detectability: ease with which the results of the risk occurring, can be detected and recognized. Where the risk occurrence can be detected easily, detectability is high

❖ Connectivity: The extent to which the risk is related to other individual project risks. Where a risk is connected to many other risks, connectivity is high

❖ Strategic impact: The potential for the risk to have a positive or negative effect on the organization strategic goals. Where the risk has a major effect on strategic goals, strategic impact is high

- ❖ Propinquity: degree to which a risk is perceived to matter by one or more stakeholders Where a risk is perceived as very significant, propinquity is high.

4- Interpersonal and Team Skills

- **Facilitation:** improves the effectiveness of the qualitative analysis of individual project risks

5- Risk Categorization

- Risks to the project can be categorized to determine the areas of the project most exposed to the effect of uncertainty by: sources of risk (e.g. Risk breakdown structure (**RBS**), Area of the project affected (e.g. using Work breakdown structure (WBS), or other useful categories (e.g. project phase, project budget and roles and responsibilities)
- Grouping risks into categories can lead to the development of more effective risk responses by focusing attention and effort on the areas of highest risk exposure

6- Data Representation

- **Probability and impact matrix**

❖ Grid for mapping the probability of each risk occurrence and its impact on project objectives if that risk occurs. The matrix specifies combinations of probability and impact that allow individual project risks to be divided into priority groups

❖ The **probability** of occurrence for each individual project risk is assessed as well as its **impact** on one or more project objectives

❖ An organization can assess a risk separately for each objective by having a separate probability and impact matrix for each. Alternatively, it may develop ways to determine one overall priority level for each risk, either by combining assessments for different objectives, or by taking the highest priority level regardless of which objective is affected

- **Hierarchical charts**

❖ Where risks have been categorized using **more than two parameters**, the probability and impact matrix cannot be used and other graphical representations are required (e.g. bubble chart)

❖ **Bubble chart** displays three dimensions of data, where each risk is plotted as a disk (bubble), and the three parameters are represented by the x-axis value, the y-axis value, and the bubble size

7- Meetings

- Project team may conduct a specialized meeting (often called a risk workshop) to discuss identified individual project risk. The goal of this meeting (Review previously identified risks, Assessment of probability and impacts, Categorization and prioritization.)
- A risk owner who will be will be responsible for planning an appropriate risk response and reporting progress on managing the risk will be allocated

<u>Perform Qualitative Risk Analysis Outputs:</u>

1- Project Document Updates

- Includes (Assumption log, Issue log, Risk register and Risk report)

Perform Quantitative Risk Analysis (Planning Process Group)

Perform Quantitative Risk Analysis is the process of numerically analyzing the combined effect of identified individual project risks and other sources of uncertainty on overall project objectives

Key benefit of this process is that it quantifies overall project risk exposure, and it can also provide additional quantitative risk information to support risk response planning

- This process is not required for every project, but where it is used, it is performed throughout the project
- Applying this process depends on availability of high-quality data about individual project risks and uncertainty, as well as a sound underlying project baseline for scope, schedule, and cost.
- Quantitative risk analysis usually requires specialized risk software and expertise. And it consumes additional time and cost.
- It is most likely appropriate for **large or complex projects**, or if it was **contractual requirement** or if a key stakeholder requires it
- Quantitative risk analysis is the only reliable method to **assess overall project risk**
- Outputs from Perform Quantitative Risk Analysis are used as inputs to the Plan Risk Responses process. recommending responses to the level of overall project risk and key individual risks

Perform Quantitative Risk Analysis Inputs:

1- Project Management Plan

- Includes (Risk management plan, Scope baseline, Schedule baseline and Cost baseline)

2- Project Documents

- Includes (Assumption log, Basis of estimates, Cost of estimates, Cost forecasts, Duration estimates and Milestone list, Resource requirements, Risk register, Risk report and Schedule forecasts)

3- Enterprise Environmental Factors

4- Organizational Process Assets

Perform Quantitative Risk Analysis Tools & Techniques:

1- Expert Judgment

2- Data Gathering

- **Interviews**: Generate inputs for the quantitative risk analysis and sources of uncertainty

3- Interpersonal and Team Skills

- **Facilitation:** skilled facilitator is useful for gathering input data during a dedicated risk workshop

4- Representation of Uncertainty

- Where the duration, cost, or resource requirement for a planned activity is uncertain, the range of possible values can be represented in the model as a probability distribution
- Most common forms are (triangular, normal, lognormal, beta, uniform or discrete)
- Individual project risks may be covered by probability distributions. Alternatively, risks may be included in the model as **probabilistic branches**, where optional activities are added to the model to represent the time and/or cost impact of the risk should it occur, and the chance that these activities actually occur in a particular simulation run matches the risk's probability
- Branches are most useful for risks that might occur independently of any planned activity
- Other sources of uncertainty may also be represented using branches to describe alternative paths through the project

5- Data Analysis

- **Simulation**

❖ Simulations are typically performed using a **Monte Carlo analysis**

❖ When running a Monte Carlo analysis for cost risk simulation uses the project cost estimates. When run it for schedule risk, the schedule network diagram and duration estimates are used

❖ An integrated quantitative cost-schedule risk analysis uses both inputs. The output is a quantitative risk analysis model

❖ Computer software is used to iterate the quantitative risk analysis model several thousand times

❖ The input values (e.g. cost estimates, duration estimates) are chosen at random for each iteration. Outputs represent the range of possible outcomes for the project (e.g. project end date or BAC)

❖ Typical outputs include a **histogram** presenting the number of iterations where a particular outcome resulted from the simulation, or a cumulative probability distribution **(S-curve)** representing the probability of achieving any particular outcome or less

❖ S-curve is an example from Monte Carlo

❖ For a quantitative schedule risk analysis, it is also possible to conduct **a criticality analysis** that determines which elements of the risk model have the greatest **effect on the project critical path**

❖ A criticality index is calculated for each element in the risk model, which gives frequency with which that element appears on the critical path during the simulation, usually expressed as a percentage

❖ The output from a criticality analysis allows the project team to focus risk response planning efforts

- **Sensitivity analysis**

- ❖ helps to determine which individual project risks or other sources of uncertainty have the **most potential impact** on project outcomes. correlates variations in project outcomes with variations in elements of the quantitative risk analysis model
- ❖ **Tornado diagram** is an example on sensitivity analysis
- ❖ Tornado diagram presents the calculated correlation coefficient for each element of the quantitative risk analysis model that can influence the project outcome
- ❖ Items are ordered by descending strength of correlation, giving the typical tornado appearance

- **Decision tree analysis**
- ❖ Used to support selection of the best of several alternative courses of action.
- ❖ Alternative paths through the project are shown in the decision tree using branches representing different decisions, each of which can have associated costs and related individual project risks
- ❖ The end-points of branches in the decision tree represent the outcome from following that particular path, which can be negative or positive
- ❖ The decision tree is evaluated by calculating the expected monetary value of each branch, allowing the optimal path to be selected

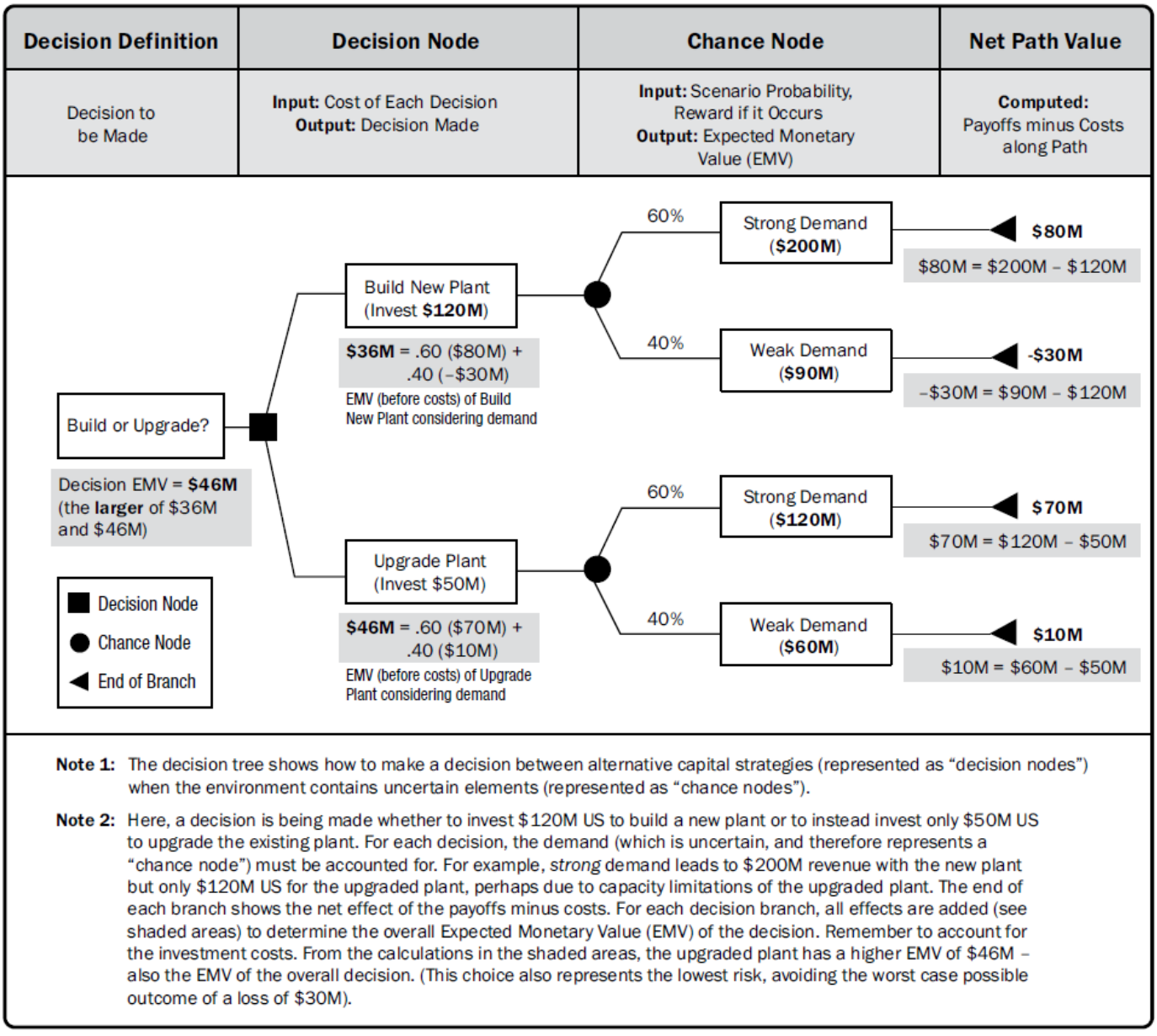
- **Influence diagram**
- ❖ Graphical aids to decision making under uncertainty. It represents a project within the project as a set of entities, outcomes, and influences, together with the relationships and effects between them
- ❖ When element in the influence diagram is uncertain as a result of the existence of individual project risks, this can be represented in the influence diagram using ranges or probability distributions.
- ❖ The influence diagram is then evaluated using a simulation technique, such as Monte Carlo analysis, to indicate which elements have the greatest influence on key outcomes
- ❖ Outputs form influence diagram includes S-curve and tornado diagram

Perform Quantitative Risk Analysis Outputs:

1- Project Document Updates

- Risk report. Which will be updated to reflect the results on quantitative analysis. It includes
- ❖ Assessment of overall project exposure. Which is reflected in two key measures (Chances of project success indicated by the probability that the project will achieve its key objective, and Degree of inherent variability remaining within the project at the time the analysis was conducted)
- ❖ Detailed probabilistic: Key outputs from quantitative risk analysis are presented such as (S-curve, tornado diagram and criticality analysis). Possible detailed results of quantitative analysis include (Amount of contingency reserve needed to provide confidence level, Identification of individual project risks, and Major drivers of oval project risk with the greatest influence)
- ❖ Prioritized list of individual project risks: This list includes those individual project risks that pose the greatest threat or present the greatest opportunity to the project, as indicated by sensitivity analysis

- Trends in quantitative risk analysis results: As the analysis is repeated at different times during the project life cycle, trends may become apparent that inform the planning of risk responses
- Recommended risk responses: The risk report may present suggested responses to the level of overall project risk exposure or key individual project risks, based on the results of the quantitative risk analysis. These recommendations will form inputs to the Plan Risk Responses process



Example Decision Tree

Plan Risk Responses (Planning Process Group)

Plan Risk Responses is the process of developing options, selecting strategies, and agreeing on actions to address overall project risk exposure, as well as to treat individual project risks

Key benefit of this process is that it identifies appropriate ways to address overall project risk and individual project risks

- This process is performed throughout the project
- This process also allocates resources and inserts activities into project documents and the project management plan as needed
- Effective and appropriate risk responses can minimize individual threats, maximize individual opportunities, and reduce overall project risk exposure
- Unsuitable risk responses can have the **converse effect**
- Once risks have been identified, analyzed, and prioritized, plans should be developed by the nominated risk owner to address project risk
- Risk responses should be appropriate for the significance of the risk, cost-effective in meeting the challenge, realistic within the project context, agreed upon by all parties involved, and owned by a responsible person.
- For large or complex projects, it may be appropriate to use a mathematical optimization model or real options analysis as a basis for a more robust economic analysis of alternative risk response.
- **contingency plan (or fallback plan)** can be developed for implementation if the selected strategy turns out not to be fully effective or if an accepted risk occurs
- **Secondary risks** are risks that arise as a direct result of **implementing a risk response**.

Plan Risk Response Inputs:

1- Project Management Plan

- Includes (Resource management plan, Risk management plan and Cost baseline)

2- Project Documents

- Includes (Lessons learned register, Project schedule, Project team assignments, Risk register, Risk report and Stakeholder register)

3- Enterprise Environmental Factors

4- Organizational Process Assets

Plan Risk Response Tools & Techniques:

1- Expert Judgment

2- Data Gathering

- Interviews

3- Interpersonal and Team Skills

- Facilitation

4- Strategies for Threats: Includes (Escalate, Avoid, Transfer, Mitigate and Accept)

- **Escalate:**

❖ Escalation is appropriate when the project team or the project sponsor agrees that a threat is **outside** the project or the proposed response would exceed the project manager authority.
❖ Escalated risks are managed at the program/portfolio level not on the project level
❖ It is important that ownership of escalated threats is accepted by the relevant party in the organization
❖ Escalated threats are not monitored further by the project team after escalation. But they are recorded in risk register for information

- **Avoid**

❖ Risk avoidance is when the project team acts to eliminate the threat or protect the project from its impact. It is appropriate for **high-priority** threats with **a high probability** of occurrence and a **large negative impact.**
❖ Avoidance may involve changing some aspect of the project management plan or changing the objective that is in jeopardy in order to eliminate the threat entirely, reducing its probability of occurrence to zero
❖ Examples of avoidance actions (Removing the cause of a threat, **Extending** the schedule, Changing the project strategy, or **Reducing** scope)
❖ Some risks can be avoided by clarifying requirements, obtaining information, improving communication, or acquiring expertise

- **Transfer**

❖ Shifting ownership of a threat to a third party to manage the risk and to bear the impact
❖ Risk transfer often involves payment of a risk premium to the party taking on the threat.
❖ Transfer actions includes (**Insurance** performance bonds, **Warranties** and **Guarantees**)
❖ Agreements may be used to transfer ownership and liability for specified risks to another party
❖ **Fixed Price contracts** are considered Transfer risk response

- **Mitigate**

❖ Action is taken to **reduce the probability** of occurrence and/or impact of a threat.

❖ Early mitigation actions are more effective than repair the damage after it occurred

❖ Examples of mitigation actions (Adopt less complex process, Conduct more **tests** and Choose **stable seller**)

❖ Mitigation may involve prototype development to reduce the risk of scaling up from a bench-scale model of a process or product

❖ Mitigation does not reduce the probability, but it reduces the impact of the threat

- **Accept**

❖ Risk acceptance acknowledges the existence of a threat, but no proactive action is taken

❖ Accept is appropriate for low-priority risks, and it may be adopted if other actions not cost-effective

❖ Acceptance can be either active or passive.

❖ Most common **active acceptance** strategy is to establish a **contingency reserve** if risk occurs

❖ Passive acceptance involves no proactive action apart from periodic review of the threat

5- Strategies of Opportunities Includes (Escalate, Exploit, Share, Enhance and Accept)

- **Escalate**

❖ This risk response is appropriate when agreed that the opportunity is **outside** the scope of the project, or would exceed the authority of the project manager

❖ Escalated opportunity are managed at program/portfolio level not project level

❖ It is important that ownership of escalated opportunities is accepted by the relevant party

❖ They are not monitored further after escalation but can be recorded in risk register

- **Exploit**

❖ Exploit strategy is selected for high-priority opportunities to ensure it is realized

❖ Exploit seeks to capture the benefit associated with the opportunity by ensuring it definitely happens and increase the probability to 100%

❖ Examples of exploit (Assigning **most talented resources** to reduce time to complete the project, or using **new technologies** to reduce cost and duration)

- **Share**

❖ transferring ownership of an opportunity to a third party so that it shares some of the benefit

❖ It is important to select the new owner of a shared opportunity carefully so they are best able to capture the opportunity for the benefit of the project

❖ Risk sharing often involves payment of a risk premium to the party taking on the opportunity

❖ Examples of sharing (Risk-sharing **partnerships**, **Teams** and **Join ventures**)

- **Enhance**

❖ Increase the probability and/or impact of an opportunity.
❖ Early enhancement is more effective than trying to improve after the opportunity has occurred
❖ Probability of occurrence of an opportunity may be increased by focusing attention on its causes
❖ When it is not possible to increase probability, an enhancement response might increase the impact
❖ Examples of enhance (**Adding more resources** to an activity to finish early)

- **Accept**

❖ Accepting an opportunity acknowledges its existence but no proactive action is taken
❖ Accept is appropriate for low-priority opportunities or if it is not possible or cost-effective to address the opportunity any further
❖ Acceptance can be either active or passive.
❖ Active strategy includes establishing contingency reserve including (time, money or resources)
❖ Passive acceptance involves no proactive action apart from periodic review of the opportunity to ensure that it does not change significantly

6- Contingent Response Strategies

- Some responses are designed for use only if certain events occur
- Prepare a response plan that will be executed only if predefined conditions occur
- Events that trigger the contingency response, such as missing intermediate milestones or gaining higher priority with a seller should be defined and tracked
- Risk response identified using this technique are often called **(contingency plans or fallback plans)**

7- Strategies for Overall Project Risk

- **Avoid:** Where the level of overall project risk is negative and outside the agreed threshold. Example (Removal of high-risk elements of scope. But if it's not possible to bring the project back within the thresholds, the project may be cancelled)
- **Exploit:** Where the level of overall project risk is positive and outside the agreed threshold. Example (Addition of high-benefit elements of scope)
- **Transfer/Share:** If the level of overall project risk is high but the organization is unable to address it effectively. A third party may be involved to manage the risk (positive or negative). Example (setting up a collaborative business structure, Joint venture, or subcontracting key elements of the project)
- **Mitigate/Enhance:** These strategies involve changing the level of overall project risk (positive or negative) to optimize the chances of achieving the project objectives. Examples (Replanning, Change the scope, Modify project priority, Change resource allocations and change delivery times)
- **Accept:** Where no proactive risk response strategy is possible to address overall project risk (positive or negative). Which can be active (contingency reserve) or passive (no proactive action)

8- Data Analysis

- **Alternative analysis:** simple comparison of the characteristics and requirements of alternative risk response which may lead to a decision on which response is most appropriate
- **Cost-benefit analysis:** If the impact of an individual project risk can be quantified in monetary terms, this method can be used. The ratio of (change in impact level) divided by (implementation cost) gives the cost effectiveness of the response strategy. Where higher ratio is more effective

9- Decision Making

- **Multicriteria decision analysis**: One or more risk response strategies may be under consideration. Multicriteria analysis uses a decision matrix to provide a systematic approach for establishing key decision criteria, evaluating and ranking alternatives and selecting a preferred option. Criteria of risk response includes “cost of response”.

Plan Risk Response Outputs:

1- Change Requests

2- Project Management Plan Updates

- Includes (Schedule management plan, Cost management plan, Quality management plan, Resource management plan, Scope baseline, Schedule baseline, Cost baseline)

3- Project Document Updates

- Includes (Assumption log, Cost forecasts, Lessons learned register, Project schedule, Project team assignments, Risk register and Risk report)

❖ Risk register updated when appropriate risk responses are chosen and agreed upon and includes (Response strategies, Action to implement the strategy, Trigger conditions and symptoms of a risk occurrence, Budget and schedule activities, Contingency plan, Fallback plans)

❖ Risk report is updated to present agreed-upon responses to overall project risk exposure and high-priority risks

Implement Risk Responses (Executing Process Group)

Implement Risk Responses is the process of implementing agreed-upon risk response plans.

Key benefit of this process is that it ensures that agreed-upon risk responses are executed as planned in order to address overall project risk exposure, minimize individual project threats, and maximize individual project opportunities

- This process is performed throughout the project
- A common problem with project risk management that no action is taken against identified risks
- Only if risk owners give the required level of effort to implement the agreed-upon responses will the overall risk exposure of the project and individual threats and opportunities be managed proactively.

Implement Risk Response Inputs:

1- Project Management Plan

- Includes Risk management plan

2- Project Documents

- Includes (Lessons learned register, Risk register, and Risk report)

3- Organizational Process Assets

Implement Risk Response Tools & Techniques:

1- Expert Judgment

2- Interpersonal and Team Skills

- **Influencing:** Some risk response actions may be owned by people **outside** the immediate project team or who have competing demands. The project manager or facilitator may be need to exercise influencing to encourage nominated risk owners to take necessary actions.

3- Project Management Information System (PMIS)

Implement Risk Response Outputs:

1- Change Requests

2- Project Documents Updates

- Includes (Issue log, Lessons learned register, Project team assignments, Risk register and Risk report)

Monitor Risks (Monitoring and Controlling Process Group)

The process of monitoring the implementation of agreed-upon risk response plans, tracking identified risks, identifying and analyzing new risks, and evaluating risk process effectiveness throughout the project.

Key benefit of this process is that it enables project decisions to be based on current information about overall project risk exposure and individual project risks

- This process is performed throughout the project

Monitor Risk Inputs:

1- Project Management Plan

- Includes Risk management plan

2- Project Documents

- Includes (Issue log, Lessons learned register, Risk register and Risk report)

3- Work Performance Data

- Contains data on project status such as risk responses that have been implemented, risks that have occurred, risks that are active and those that have been closed out.

4- Work Performance Reports

- Provide information from performance measurements that can be analyzed to provide project work performance information including variance analysis, earned value data, and forecasting data

Monitor Risk Tools & Techniques:

1- Data Analysis

- **Technical performance analysis:** Compares technical accomplishments during project execution to the schedule of technical achievement. It requires the definition of objective, quantifiable measures of technical performance, which can be used to compare actual results against targets. This may include weight, transaction, times and number of defects
- **Reserve analysis:** During execution some risks may occur with positive or negative impact on budget or schedule contingency reserve. Reserve analysis compares the amount of the contingency reserves remaining to the amount of risk remaining at any time in project. To determine of the remaining reserve is adequate. This may graphically presented in "**Burndown chart**"

2- Audits

- The project manager is responsible for ensuring that risk audits are performed at an appropriate frequency. Audits may be included during routine project review meetings or at risk review meeting or separate audit meeting is held

3- Meetings

- **Risk reviews:** Examine and document the effectiveness of risk responses in dealing with overall and individual project risks. Risk review meeting can be part of periodic project status meeting. And reassess some previously identified risks.

Monitor Risk Outputs:

1- Work Performance Information

- Information on how project risk management is performing by comparing the individual risks that have occurred with the expectation of how they would occur. This information indicates the effectiveness of the response planning and response implementation processes

2- Change Requests

3- Project Management Plan Updates

- Any change to any component of project management plan will update it component

4- Project Document Updates

- Includes (Assumption log, Issue log, Lessons learned register, Risk register and Risk report)

5- Organizational Process Assets Updates

- Includes (Templates for risk management plan, Risk register/reports, and RBS)

Chapter 11 (Project Procurement Management)

- Project Procurement Management includes the processes necessary to purchase or acquire products, services, results needed from outside the project team
- Project Procurement Management includes the management and control processes required to develop and administer agreements such as contracts, purchase orders, memoranda of agreements (MOAs), or internal service level agreements (SLAs).
- Most project management processes, there can be significant legal obligations and penalties tied to the procurement process.
- Project manager does not have to be expert in procurement, but he should be familiar enough to make intelligent decisions
- Project manager is typically not authorized to sign legal agreements binding the organization
- The Project Procurement Management processes involve agreements that describe the relationship between two parties (Buyer and Seller)
- contract should clearly state the deliverables and results expected, including any knowledge transfer from the seller to the buyer. Anything not in the contract **cannot be legally enforced**
- A purchasing contract includes terms and conditions and may incorporate other buyer specifics as to what the seller is to perform or provide. Project management team is responsible that all procurement meets the specific needs of the project
- An agreement can be a contract, an SLA, an understanding an MOA, or a purchase order.
- Departments that usually deals with procurements are (purchasing, contracting, procurement or acquisitions)
- A complex project may involve managing multiple contracts simultaneously or in sequence
- The seller may be identified as contractor, vendor, service provider, or supplier
- The buyer may be the owner of the final product, a subcontractor, the acquiring organization, a service requestor, or the purchaser.
- The seller can be viewed during the contract life cycle first as a **bidder**, then as the **selected source**, and then as the contracted **supplier or vendor**
- The seller itself may become a buyer of lower-tiered products, services, and materials from subcontractors and suppliers
- In smaller companies without purchasing department that project manager has the authority to negotiate and sign directly (decentralized purchasing)
- When the purchasing and signing contracts is performed by specific department then it is called (centralized purchasing)
- Online tools for procurement now give the buyers a single point where procurements can be advertised and provide sellers with a single source to find procurement documents and complete them directly online
- Building Information Model (BIM) is used in construction projects to save time and money

- The buyer will be required to accept the risks that the contractors do not have control over, such as changing corporate policies
- Supply chain management helps managing items in long and international projects in advance
- Webcam can be installed on some sites so the stakeholders can view. And it helps minimizing disputes relating the work on sites
- In some projects many sellers can submit initial work product on a paid basis before making the full commitment to project scope. Which accelerates the momentum by allowing the buyer to evaluate potential partners
- In agile environments, specific sellers may be used to extend the team. This collaborative working relationship can lead to a shared risk procurement model where both the buyer and the seller share in the risk and rewards associated with the project.
- In large projects a governing agreement such as Master Service Agreement (MSA) may be used for to allow changes to occur on adaptive scope without impacting the overall contract.

Plan Procurement Management (Planning Process Group)

Plan Procurement Management is the process of documenting project procurement decisions, specifying the approach and identifying potential sellers

Key benefit of this process is that it determines whether to acquire goods and services from outside the project and, if so, what to acquire as well as how and when to acquire it.

- This process is performed **once** or at predefined points in the project.
- Defining roles and responsibilities related to procurement should be done early in the Plan Procurement Management process
- Typical steps for this process is to (Prepare procurement statement of work (**SOW**) or terms of reference (**TOR**), Prepare high cost estimate for budget, Advertise the opportunity, Identify sellers shortlist, Prepare bid documents, Prepare and submit proposal, Conduct technical evaluation, Perform cost evaluation, Select the winning proposal, and Sign contracts.
- The requirements of the project schedule can significantly influence the strategy during the Plan Procurement Management process
- The elements of scope in scope base line develop Statement of Work (SOW) and Terms of Reference (TOR)
- If the project team does not have the skills to perform the procurement activities for which they are responsible, additional resources will be acquired or training will need to be provided, or both.

Plan Procurement Management Inputs:

1- Project Charter

2- Business Documents

- **Business case:** procurement strategy and business case need to be aligned to ensure the business case remains valid
- **Benefits management plan:** describes when specific project benefits are expected to be available, which will drive procurement dates and contract language

3- Project Management Plan

- Includes (Scope management plan, Quality management plan, Resource management plan and Scope baseline)

4- Project Documents

- Includes (Milestone list, Project team assignments, Requirements documentations, Requirements traceability matrix, Resource requirements, Risk register and Stakeholder register)

5- Enterprise Environmental Factors

6- Organizational Process Assets

- Includes (Preapproves seller lists, Formal procurement policies, procedures and guidelines, Contract types and Cost-reimbursable contracts)

❖ All legal contractual relationships generally fall into (Fixed-price contracts and Cost-reimbursable contracts)

❖ Fixed Price contracts considered as Risk Transfer

❖ **Fixed-price contracts**: This category of contracts involves setting a fixed total price for a defined product to be provided. These contracts should be used when the requirements are well defined and no significant changes to the scope are expected. Types of fixed-price contract include

- **Firm fixed price (FFP):** The **most commonly** used contract type is the FFP. It is **favored** by most **buying** organizations because the price for goods is set at the outset and not subject to change unless the scope of work changes.
- **Fixed price incentive fee (FPIF):** This fixed-price arrangement gives the buyer and seller some **flexibility** in that it allows for deviation from performance, with financial incentives tied to achieving agreed-upon metrics. Typically, such financial incentives are related to cost, schedule, or technical performance of the seller. Under FPIF contracts, a price ceiling is set, and all costs above the price ceiling are the **responsibility of the seller**.
- **Fixed price with economic price adjustments (FPEPA):** This type is used whenever the seller's performance period **spans** a considerable period of **years**, or if the payments are made in a **different currency**. It is a fixed-price contract, but with a special provision allowing for predefined final adjustments to the contract price due to changed conditions, such as inflation changes or cost increases (or decreases) for specific commodities.

❖ **Cost-reimbursable contracts:** This category of contract involves payments (cost reimbursements) to the seller for all legitimate **actual costs** incurred for completed work, **plus a fee** representing seller profit. This type should be used if the scope of work is **expected to change** significantly during the execution of the contract. Variations include

- **Cost plus fixed fee (CPFF):** The seller is reimbursed for all allowable costs for performing the contract work and receives a **fixed-fee payment** calculated as a **percentage** of the initial estimated project costs. Fee amounts do not change unless the scope changes
- **Cost plus incentive fee (CPIF):** The seller is reimbursed for all allowable costs for performing the contract work and receives a **predetermined incentive fee** based on achieving certain performance objectives as set forth in the contract. In CPIF contracts, if the final costs are less or greater than the original estimated costs then both the buyer and seller **share costs** from the departures based upon a prenegotiated cost-sharing formula, for example (80/20 split over/under target costs based on the actual performance of the seller)
- **Cost plus award fee (CPAF):** The seller is reimbursed for **all legitimate costs**, but the majority of the fee is earned based on the **satisfaction** of certain broad subjective

performance criteria that are defined and incorporated into the contract. The determination of fee is based solely on the subjective determination of seller performance by the buyer and is generally not subject to appeals.

- **Time and material contracts (T&M) (Time and Means):** Hybrid type of contractual arrangement with aspects of both cost-reimbursable and fixed-price contracts. They are often used for staff augmentation, acquisition of experts, and any outside support when a precise statement of work cannot be quickly prescribed.

Plan Procurement Management Tools & Techniques:

1- Expert Judgment

2- Data Gathering

- **Market research:** Includes examination of industry and specific seller capabilities. Procurement teams may leverage information gained at conferences, online reviews, and a variety of sources to identify market capabilities.

3- Data analysis

- **Make-or-buy analysis:** Used to determine whether work or deliverables can best be accomplished by the project team or should be purchased from outside sources. Factors to consider in the make-or-buy decision include the organization's current resource allocation and their skills and abilities, the need for specialized expertise, the desire to not expand permanent employment obligations, and the need for independent expertise. It also includes evaluating the risks involved with each make-or-buy decision.

  Make-or-buy analysis may use payback period, return on investment (ROI), internal rate of return (IRR), discounted cash flow, net present value (NPV), benefit/cost analysis (BCA), or other techniques in order to decide whether to include something as part of the project or purchase it externally

4- Source Selection Analysis

- It is necessary to review the prioritization of the competing demands for the project before deciding on the selection method.
- Evaluation method in the procurement documents so bidders know how they will be evaluated. Common methods of selection include

- **Least cost:** Appropriate for procurements of a standard or routine nature where well-established practices and standards exist and from which a specific and well-defined outcome is expected which can be executed at different costs.

- ❖ **Qualifications only:** Appropriate when the time and cost of a full selection process would not make sense because the **value** of the procurement is **relatively small**. The buyer establishes a short list and selects the bidder with the best credibility, qualifications, experience, areas of specialization.
- ❖ **Quality-based/highest proposal score:** The selected firm is asked to submit a proposal with both technical and cost details and is then invited to negotiate the contract if the technical proposal proves acceptable. Using this method, technical proposals are first evaluated based on the quality of the technical solution offered. The seller who submitted the highest-ranked technical proposal is selected if their financial proposal can be negotiated and accepted.
- ❖ **Quality and cost-based:** allows cost to be included as a factor in the seller selection process. In general, when risk and/or uncertainty are greater for the project, quality should be a key element when compared to cost.
- ❖ **Solo source:** The buyer asks a specific seller to prepare technical and financial proposals, which are then negotiated. Since there is no competition, this method is acceptable only when properly justified and should be viewed as an exception.
- ❖ **Fixed Budget:** disclosing the available budget to invited sellers in the RFP and selecting the highest-ranking technical proposal within the budget. Because sellers are subject to a cost constraint, they will adapt the scope and quality of their offer to that budget. The buyer should therefore ensure that the budget is compatible with the SOW and that the seller will be able to perform the tasks within the budget. This method is appropriate only when the SOW is precisely defined, no changes are anticipated, and the budget is fixed and cannot be exceeded.

5- Meetings

- Meetings are useful to gather more information by meeting with potential bidders

<u>Plan Procurement Management Outputs:</u>

1- Procurement Management Plan

- Contains the activities to be undertaken during the procurement process. It should document whether international competitive bidding, national competitive bidding, local bidding should be done
- If project is financed externally the procurement should be aligned with it

2- Procurement Strategy

Once the make-or-buy analysis is complete and the decision is made to acquire from outside the project, a procurement strategy should be identified. The objective of the procurement strategy is to determine the project delivery method, the type of legally binding agreement(s), and how the procurement will advance through the procurement phases.

- Delivery methods for professional services include (buyer/services providers with no subcontractors, buyer/ services provider with subcontracting allowed, joint venture between buyer and services provider, and buyer/ services provider acts as the representative)

- Delivery methods for industrial or commercial construction, project delivery methods include turnkey, design build (DB), design bid build (DBB), design build operate (DBO), build own operate transfer (BOOT).
- Fixed price contracts are suitable when the type of work is predictable and the requirements are well defined and not likely to change.
- Cost plus contracts are suitable when the work is evolving, likely to change, or not well defined
- Incentives and awards may be used to align the objectives of buyer and seller

3- Bid Documents

- Bid documents are used to solicit proposals from prospective sellers. Terms such as bid, tender, or quotation are generally used when the seller selection decision is based on price, while a term such as proposal is generally used when other considerations such as technical capability or technical approach are the most important. Bidding documents include

❖ **Request for information (RFI):** An RFI is used when more **information** on the goods and services to be acquired is needed from the sellers. It will typically be followed by an RFQ or RFP.

❖ **Request for quotation (RFQ):** An RFQ is commonly used when **more information is needed** on how vendors would satisfy the requirements and/or how much it will **cost**

❖ **Request for proposal (RFP):** An RFP is used when there is a **problem** in the project and the solution is not easy to determine. This is the most format of the “request for” documents and has strict procurement rules for content timeline and seller responses.

- These documents include a description of the desired form of the response, the relevant procurement SOW, and any required contractual provisions
- Procurement documents are required to be sufficiently detailed to ensure consistent, appropriate responses, but flexible enough to allow consideration of any seller suggestions for better ways to satisfy the same requirements

4- Procurement Statement of Work (SOW)

- The statement of work (SOW) for each procurement is developed from the project scope baseline and defines only that portion of the project scope that is to be included within the related contract.
- SOW describes the procurement item in sufficient detail to allow prospective sellers to determine if they are capable of providing the products, services or results
- Details can vary based on the nature of the item, the needs of the buyer, or the expected contract form.
- Information included in a SOW can include specifications, quantity desired, quality levels, performance data, period of Information included in a SOW can include specifications, quantity desired, quality levels, performance data, period
- The SOW can be revised as required as it moves through the procurement process until incorporated into a signed agreement

- Terms of reference (TOR) is sometimes used when contracting for services. Similar to the procurement SOW.

5- Source Selection Criteria

- In choosing evaluation criteria, the buyer seeks to ensure that the proposal selected will offer the best quality for the services required.
- For international projects, evaluation may include “local content” requirements
- The specific criteria may be a numerical score, color-code, or a written description

6- Make-Or-Buy Decisions

- A make-or-buy analysis results in a decision as to whether particular work can best be accomplished by the project team or needs to be purchased from outside sources

7- Independent Cost Estimates

- For large procurements, the procuring organization may elect to either prepare its own independent estimate or have a cost estimate prepared by an **outside** professional estimator to serve as a **benchmark** on proposed responses
- Significant differences in cost estimates can be an indication that the procurement SOW was deficient or **ambiguous** or that prospective sellers either misunderstood or failed to respond fully to the procurement SOW

8- Change Requests

9- Project Documents Updates

- Includes (Lessons learned register, Milestone list, Requirements documentation (either technical requirements that the seller is required to satisfy or contractual requirements), Requirements traceability matrix, Risk register and Stakeholder register)

10- Organizational Process Assets Updates

- Includes Information on qualified sellers

Conduct Procurements (Executing Process Group)

Conduct Procurements is the process of obtaining seller responses, selecting a seller, and awarding a contract

Key Benefit is that it selects a qualified seller and implements the legal agreement for delivery.

- This process is performed periodically thought the project as needed

Conduct Procurements Inputs:

1- Project Management Plan

- Includes (Scope management plan, Requirements management plan, Communications management plan, Risk management plan, Procurement management plan, Configuration management plan and Cost baseline)

2- Project Documents

- Includes (Lessons learned register, Project schedule, Requirements documentation, Risk register and Stakeholder register)

3- Procurement Documentation

- Procurement documentation provides a written record used in reaching the legal agreement, and may include older documents predating the current project. Procurement documentation can include
  - **Bid documents:** RFI, RFP and RFQ
  - **Procurement statement of work (SOW):** provides sellers with a clearly stated set of goals, requirements, and outcomes from which they can provide a quantifiable response.
  - **Independent cost estimate:** Developed either internally or externally to provide a reasonable check against proposals submitted by bidders.
  - **Source selection criteria:** How proposals will be evaluated. Sometimes to mitigate risks the buyer may sign agreements with more than one seller.

4- Seller Proposals

- Prepared in response to a procurement document package, form the basic information that will be used by an evaluation body to select one or more successful bidders (sellers).

5- Enterprise Environmental Factors

6- Organizational Process Assets

Conduct Procurements Tools & Techniques:

1- Expert Judgment

2- Advertising

- communicating with users or potential users of a product, service, or result. Existing lists of potential sellers can be expanded by placing advertisements in general circulation publications such as selected newspapers or in specialty trade publications.
- Most government jurisdictions require public advertising or online posting of pending government contracts

3- Bidder Conferences

- Bidder conferences (also called contractor conferences, vendor conferences, and pre-bid conferences) are meetings between the buyer and prospective sellers prior to proposal submittal.
- They are used to ensure **that all prospective bidders have a clear and common understanding** of the procurement and no bidders receive preferential treatment

4- Data Analysis

- **Proposal Evaluation:** Proposals are evaluated to **ensure** they are complete and respond in full to the bid documents, procurement statement of work, source selection criteria and any other documents that went out in the bid package

5- Interpersonal and Team Skills

- **Negotiation**: discussion aimed at reaching an agreement. Procurement negotiation clarifies the structure, rights, and obligations of the parties and other terms of the purchases so that mutual agreement can be reached prior to signing the contract
- The negotiation should be led by a member of the procurement team that has the authority to sign contracts, the manager and team members may be present during negotiation

Conduct Procurements Outputs:

1- Selected Sellers

- The selected sellers are those who have been judged to be in a competitive range based on the outcome of the proposal or bid evaluation. Final approval of complex, high-value, high-risk procurements will generally require organizational senior management approval prior to award

2- Agreements

- A contract is a mutually binding agreement that obligates the seller to provide the specified products. obligates the buyer to compensate the seller; and represents a legal relationship that is subject to remedy in the courts. The major components in an agreement will vary but includes
- Procurement statement of work or major deliverables;
- Schedule, milestones, or date by which a schedule is required;
- Performance reporting;
- Pricing and payment terms;
- Inspection, quality, and acceptance criteria;
- Warranty and future product support;
- Incentives and penalties;
- Insurance and performance bonds;
- Subordinate subcontractor approvals;
- General terms and conditions;
- Change request handling; and
- Termination clause and alternative dispute resolution mechanisms.

3- Change Requests

4- Project Management Plan Updates

- Includes (Requirements management plan, Quality management plan, Communications management plan, Risk management plan, Procurement management plan, Scope baseline, Schedule baseline and Cost baseline.

5- Project Documents Updates

- Includes (Lessons learned register, Requirements documentation, Requirements traceability matrix, resource calendars, Risk register and Stakeholder register)

7- Organizational Process Assets Updates

- Includes (Listing of prospective and prequalified sellers and information on relevant experience with the sellers)

Control Procurements (Monitor & Control Process Group)

Control Procurements is the process of managing procurement relationships; monitoring contract performance, and making changes and corrections as appropriate; and closing out contracts

Key benefit is that it ensures that both the seller′s and buyer′s performance meet the project′s requirements according to the terms of the legal agreement

- This process is performed throughout the project as needed
- Both buyer and seller are required to ensure both parties meet their contractual obligations
- Because of the legal aspect, many organizations treat contract administration as an organizational function that is separate from the project. While a procurement administrator may be on the project team, this individual typically reports to a supervisor from a different department
- The quality of the controls, including the independence and credibility of procurement audits, is critical to the reliability of the procurement system
- Control Procurements has a financial management component that involves monitoring payments to the seller.
- A contract that requires payments linked to project output and deliverables rather than inputs such as labor hours has better controls.
- Agreements can be **amended at any time prior to contract closure** by mutual consent, in accordance with the change control terms of the agreement. Such amendments are typically captured in writing

Control Procurements Inputs:

1- Project Management Plan

- Includes (Requirements management plan, Risk management plan, Procurement management plan, Change management plan and Schedule baseline

2- Project Documents

- Includes (Assumption log, Lessons learned register, Milestone list, Quality Reports, Requirements documentation, Requirements traceability matrix, Risk register and Stakeholder register)

3- Agreements

4- Procurement documentation

5- Approved Change Requests

- Approved change requests can include modifications to the terms and conditions of the contract including SOW, pricing and product description
- All procurement-related changes are formally documented in writing and approved before being implemented through the Control Procurements process
- Change requests may come from the seller or the buyer

6- Work Performance Data

- Includes (Technical Performance, activities that has started/progress/completed, and costs that have been incurred or committed and also seller invoices that has been paid

7- Enterprise Environmental Factors

8- Organizational Process Assets

<u>Control Procurements Tools & Techniques:</u>

1- Expert Judgment

2- Claims Administration

- Contested changes and potential constructive changes are those requested changes where the buyer and seller cannot reach an agreement on compensation for the change or cannot agree that a change has occurred which is called "**claims**"
- Claims become **dispute** when not resolved and finally **appeals**
- If the parties themselves do not resolve a claim, it may have to be handled in accordance with **alternative dispute resolution (ADR)** typically following procedures established in the contract
- **Negotiation** should be the **first step** in solving the claims before using the ADR

3- Data Analysis

- **Performance Reviews:** measure, compare, and analyze quality, resource, schedule and cost performance against the agreement
- **Earned Value Analysis (EVA):** Schedule and cost variances along with schedule and cost performance indexes are calculated to determine the degree of variance from target
- **Trend Analysis:** develop a forecast estimate at completion (EAC) for cost performance to see if performance is improving or deteriorating

4- Inspection

- Structured review of the **work being performed** by the contractor involves a simple review of the deliverables or an actual physical review of the work itself.

- On a construction/engineering/infrastructure project inspections involve **walkthroughs** of the site by both the buyer and the contractor to ensure a **mutual understanding** of the work in progress.

5- Audits

- Structured review of the **procurement process**. Rights and obligations related to audits should be described in the procurement contract

Control Procurements Outputs:

1- Closed Procurements

- The buyer, usually through its authorized procurement administrator, provides the seller with formal written notice that the contract has been completed
- Requirements for formal procurement closure are usually defined in the terms and conditions of the contract and included in the procurement management plan
- All deliverables should be provided on time and meet technical quality requirements
- There should be no outstanding claims or invoices and all payments have been made

2- Work Performance Information

- Information how seller is performing and cost incurred and accepted against SOW

3- Procurement Documentations Updates

- Includes schedule, requested unapproved contract changes and approved changes

4- Change Requests

- Requests but unresolved changed are identified and documented by project correspondence

5- Project Management Plan Updates

- Includes (Risk management plan, Procurement management plan, Scheudle baseline and Cost baseline)

6- Project Document Updates

- Includes (Lessons learned register, Resource requirements, Requirements traceability matrix, Risk register and Stakeholder register)

7- Organizational Process Assets Updates

- Includes (Payment schedule and requests, Seller performance evaluation documentation, Prequalified seller list updates, Lessons learned repository and Procurement file)

Chapter 11 (Project Stakeholder Management)

- Every project has stakeholders who are impacted by or can impact the project in a positive or negative way.
- The process of stakeholder identification and engagement should commence as soon as possible after the project charter has been approved, the project manager has been assigned and the team begins to form.
- The key to effective stakeholder engagement is a focus on continuous communication with all stakeholders, including team members.
- The process of identifying and engaging stakeholders for the benefit of the project is iterative
- Although the processes in Project Stakeholder Management are described only once, the activities of identification, prioritization, and engagement should be reviewed and updated routinely specially when (Project moves through different phases, if some stakeholder no longer involved or if new stakeholder joined, or if there are significant changes in the organization)
- Trends and practices in Project Stakeholder Management includes (Identify all stakeholders, Ensure all team members involved in stakeholder engagement activities, Review stakeholder community regularly, and capture the value of effective stakeholder engagement)
- Adaptive teams engage with stakeholders directly rather than going through layers of management
- In order to accelerate the sharing of information within and across the organization, agile methods promote aggressive transparency.

Identify Stakeholders (Initiating Process Group)

Identify Stakeholders is the process of identifying project stakeholders regularly and analyzing and documenting relevant information regarding their interests, involvement, interdependencies, influence, and potential impact on project success.

Key benefit of this process is that enables the project team to identify the appropriate focus for engagement of each stakeholder or group stakeholders

- This process is performed periodically throughout the project
- This process frequently occurs for the **first time** in a project either **prior** to or at the **same time** the **project charter** is developed and approved
- It is **repeated** as necessary, but should be performed at start of each phase or when a significant change in the organization occurs
- Each time the identification process is repeated, the project management plan components and project documents should be consulted to identify relevant project stakeholders.

Identify Stakeholders Inputs:

1- Project Charter

- Identifies Key stakeholders list, it may contain information about their responsibilities

2- Business Documents

- **Business case:** Identifies project objectives and **initial list** of stakeholders affected by the project
- **Benefits management plan:** Expected plan for realizing the benefits claimed in business case. It may identify individual and groups that will **benefit** from the **delivery of project outcomes**

3- Project Management Plan

- Includes (Communications management plan and stakeholder management plan)

4- Project Documents

- Includes Change log, Issue log and Requirements documentations

5- Agreements

- Agreement can contain reference to additional stakeholders

6- Enterprise Environmental Factors

7- Organizational Process Assets

Identify Stakeholders Tools & Techniques:

1- Expert Judgment

2- Data Gathering

- **Questionnaires and surveys**: include one-on-one reviews, focus group sessions, or other mass information collection techniques.
- **Brainstorming**: Used to identify stakeholders can include both brainstorming and brain writing
    - ❖ **Brain writing**: allows individual participants time to consider the question(s) individually before the group creativity session is held. The information can be gathered in face-to-face groups or using virtual environments supported by technology.

3- Data Analysis

- **Stakeholder analysis:** Results in a list of stakeholder and relevant information such as their positions in the organization, roles on the project "stakes", expectations, attitude (their level of support for the project) and their interest in information about the project. Stakeholder stakes include (Interest, Rights (legal or moral), ownership, Knowledge and Contribution)
- **Document analysis:** Assess the available project documentations and lessons learned from previous projects to identify stakeholders and other supporting information

4- Data Representation

- **Stakeholder mapping/representation:** Method of categorizing stakeholder using various methods which assist the team in building relationships with the identified project stakeholders. Include

❖ **Power/interest grid, Power/influence grid or impact/influence grid:** Each of these techniques supports a grouping of stakeholders according to their level of **authority** (**power**), level of **concern** about the project's outcomes (**interest**) and ability to **influence**/involvement the outcomes of the project (**influence**). These classifications are useful for **small projects**

❖ **Stakeholder cube**: This is a refinement of the grid models previously mentioned. This model combines the grid elements into a **three-dimensional** model that can be useful to project managers and teams in identifying and engaging their stakeholder community. It provides a model with **multiple dimensions** that improves the depiction of the stakeholder community.

❖ **Salience Model:** Describes classes of stakeholders based on assessments of their **power** (level of authority or ability to influence the outcomes of the project), **urgency** (need for immediate attention, either time-constrained or relating to the stakeholders' high stake in the outcome), and **legitimacy** (their involvement is appropriate). The salience model is useful for **large complex communities** of stakeholders or where there are **complex** networks of **relationships** within the community. It is also useful in determining the relative importance of the identified stakeholders.

- **Directions of influence:** Classifies stakeholders according to their influence on the work of the project or the project team itself. Stakeholders can be classified in the following ways
    - Upward (senior management)
    - Downward (team or specialists contribute knowledge or skill)
    - Outward (Stakeholders outside the project such as suppliers, government departments, end users and regulators)
    - Sideward (Peers of project manager such as other project managers or middle manager who are in competition)

- **Prioritization:** Prioritizing stakeholders may be necessary for projects with a **large number of stakeholders**, where the membership of the stakeholder community is **changing frequently**, or when the relationships between stakeholders and the project team or within the stakeholder community are complex

5- Meetings

<u>Identify Stakeholders Outputs:</u>

1- Stakeholder Register

- Contains information about identified stakeholders that includes
- **Identification information**. Name, organizational position, location and contact details, and role on the project
- **Assessment information**. Major requirements, expectations, potential for influencing project outcomes, and the phase of the project life cycle where the stakeholder has the most influence or impact.
- **Stakeholder classification**. Internal/external, impact/influence/power/interest, upward/downward/outward/sideward, or any other classification model chosen by the project manager

2- Change Requests

- During first iteration there will be no changes. However, throughout the project new stakeholder or new information about them may result change request to the product, project management plan or project documents

3- Project Management Plan Updates

- Includes (Requirements management plan, Communication management plan, Risk management plan and stakeholder engagement plan)

4- Project Documents Updates

- Includes (Assumption log, Issue log and Risk register)

Plan Stakeholder Engagement (Planning Process Group)

Plan Stakeholder Engagement is the process of developing approaches to involve project stakeholders based on their needs, expectations, interests, and potential impact on the project

Key benefit is that it provides an actionable plan to interact effectively with stakeholders.

- This process is performed **periodically** throughout the project.
- The first version of the stakeholder engagement plan is developed after the initial stakeholder community has been identified by the Identify Stakeholder process
- The stakeholder engagement plan is updated regularly to reflect changes to the stakeholder community

Plan Stakeholder Engagement Inputs:

1- Project Charter

- Includes information on the project purpose, objectives, and success criteria that can be taken into consideration when planning how to engage stakeholders

2- Project Management Plan

- Includes (Resource management plan, Communications management plan, Risk management plan)

3- Project Documents

- Includes (Assumption log, Change log, Issue log, Project schedule, Risk register and Stakeholder register)

4- Agreements

- When planning for the engagement of contractors and suppliers, coordination usually involves working with the procurement/contracting group in the organization to ensure contractors and suppliers are effectively managed

5- Enterprise Environmental Factors

6- Organizational Process Assets

Plan Stakeholder Engagement Tools & Techniques:

1- Expert Judgment

2- Data Gathering

- **Benchmarking:** Results of stakeholder analysis are compared with information from other organizations or other projects that are considered to be world class

3- Data Analysis

- **Assumption and constraint analysis:** Analysis of current assumptions and constraints may be conducted in order to **tailor** appropriate engagement **strategies**
- **Root cause analysis:** identifies underlying **reasons** for the level of **support** of project stakeholders in order to select the appropriate strategy to improve their level of engagement.

4- Decision Making

- **Prioritization/ranking**: Stakeholder requirements need to be prioritized and ranked, as do the stakeholders themselves. Stakeholders with the most interest and the highest influence are often prioritized at the top of the list.

5- Data Representation

- **Mind Mapping:** Visually organize information about stakeholders and their relationship to each other and the organization.

- **Stakeholder engagement assessment Matrix:** supports comparison between the current engagement levels of stakeholders and the desired engagement levels required for successful project delivery. The engagement level of stakeholders can be classified as follows:
    - ❖ Unware: Unaware of the project and potential impacts
    - ❖ Resistant. Aware of the project and potential impacts but resistant to any changes that may occur. These stakeholders are usually unsupportive
    - ❖ Neutral. Aware of the project, but neither supportive nor unsupportive.
    - ❖ Supportive. Aware of the project and potential impacts and supportive of the work
    - ❖ Leading. Aware of the project and potential impacts and actively engaged in ensuring that the project in success

6- Meetings

<u>Plan Stakeholder Engagement Outputs:</u>

1- Stakeholder Engagement Plan

- Component of the project management plan that identifies the **strategies** and **actions** required to promote productive **involvement** of stakeholders in **decision making** and execution
- It can be formal or informal and highly detailed or broadly framed, based on the needs of the project.
- The stakeholder engagement plan may include but is not limited to specific strategies or approaches for engaging with individuals or groups of stakeholders.

Manage Stakeholder Engagement (Executing Process Group)

Manage Stakeholder Engagement is the process of communicating and working with stakeholders to meet their needs and expectations, address issues, and foster appropriate stakeholder involvement

Key benefit of this process is that it allows the project manager to increase support and minimize resistance from stakeholders

- This process in performed throughout the project
- Manage stakeholder engagement involves (Engaging stakeholder at appropriate project stages, Manage stakeholder expectations through negotiations and communications, Address any risks related to stakeholders management and Clarifying and resolving identified issues)
- Managing stakeholder engagement helps to ensure that stakeholders clearly understand the project goals, objectives, benefits, and risks for the project, as well as how their contribution will enhance project success

Manage Stakeholder Engagement Inputs:

1- Project Management Plan

- Includes (Communications management plan, Risk management plan, Stakeholder management plan and Change management plan)

2- Project Documents

- Includes (Change log, Issue log, Lessons learned register and Stakeholder register)

3- Enterprise Environmental Factors

4- Organizational Process Assets

Manage Stakeholder Engagement Tools & Techniques:

1- Expert Judgment

2- Communication Skills

- The project management team uses feedback to assist in understanding stakeholder reaction to the various project management activities and key decisions. Feedback may be collected by (conversations, Issue identification, Meetings, Progress reporting and Surveys)

3- Interpersonal and Team Skills

- **Conflict management:** Project manager ensures conflicts are resolved in timely manner
- **Cultural awareness:** help the project manager and team to communicate effectively by considering cultural differences and the requirements of stakeholders
- **Negotiation:** helps in achieving support or agreement that supports the work of the project or its outcomes and to resolve conflicts within the team or with other stakeholders
- **Observations/conversation:** used to stay in touch with the work and attitudes of project team members and other stakeholders
- **Political awareness:** achieved through understanding the power relationships within and around the project

4- Ground Rules

- **Set expected behavior** for project team members as well as other stakeholders with regard to stakeholder engagement as defined in team charter.

5- Meetings

- Include (Decision making, Issue resolution, Lessons learned and retrospectives, Project kick-off, Spring planning and Status updates meetings)

<u>Manage Stakeholder Engagement Outputs:</u>

1- Change Requests

2- Project Management Plan Updates

- Includes (Communication management plan and Stakeholder engagement plan)

3- Project Documents Updates

- Includes (Change log, Issue log, Lessons learned register and Stakeholder register)

Monitor Stakeholder Engagement (Monitor & Controlling Process Group)

Monitor Stakeholder Engagement is the process of monitoring project stakeholder relationships and tailoring strategies for engaging stakeholders through modification of engagement strategies and plans

Key benefit of this process is that it maintains or increases the **efficiency and effectiveness** of stakeholder engagement activities as the project evolves and its environment changes.

- This process is performed throughout the project

Monitor Stakeholder Engagement Inputs:

1- Project Management Plan

- Includes (Resource management plan, Communications management plan and Stakeholder engagement plan)

2- Project Documents

- Includes (Issue log, Lessons learned register, Project communications, Risk register and Stakeholder register)

3- Work Performance Data

- Such as which stakeholders are supportive of the project and their level and type of engagement

4- Enterprise Environmental Factors

5- Organizational Process Assets

Monitor Stakeholder Engagement Tools & Techniques:

1- Data Analysis

- **Alternatives analysis:** Evaluate options to respond to variances
- **Root cause analysis:** Determine the basic underlying reason that stakeholder engagement is not having the planned effect
- **Stakeholder analysis:** Helps to determine the position of stakeholder anytime at the project

2- Decision Making

- **Multicriteria decision analysis:** Criteria for successful stakeholder engagement are prioritized and weighted to identify the most appropriate choice
- **Voting:** helps in selecting best response for a variance in stakeholder engagement.

3- Data Representation

- **Stakeholder engagement assessment matrix:** Monitors stakeholder engagement through tracking changes in level of engagement for each stakeholder

4- Communication Skills

- **Feedback:** Ensure that the information to stakeholders is received and understood.
- **Presentations:** Presentations provide clear information to stakeholders.

5- Interpersonal and Team skills

- **Active listening:** Reduce misunderstandings and other miscommunication.
- **Cultural awareness:** Help the project manager to plan communications based on the cultural differences and requirements of stakeholders and team members.
- **Leadership:** Successful stakeholder engagement requires strong leadership skills to communicate the vision and inspire stakeholders to support the work and outcomes of the project
- **Networking:** Ensures access to information about levels of engagement of stakeholders
- **Political awareness:** Understand the strategies of the organization, understand who wields power and influence in this arena, and to develop an ability to communicate with these stakeholders.

6- Meetings

- Include (Status, Standup meetings and retrospectives)
- Meetings could be face-to-face or voice-to-voice

<u>Monitor Stakeholder Engagement Outputs:</u>

1- Work Performance Information

- Include information about status of stakeholder engagement such as (current level support and compared to desired level as defined in stakeholder engagement assessment matrix)

2- Change Requests

3- Project Management Plan Updates

- Includes (Resource management plan, Communications Management plan and Stakeholder management plan)

4- Project Documents Updates

- Includes (Issue log, Lessons learned register, Risk register and Stakeholder register)

Examination Content Outline (PM Tasks)

PERFORMANCE DOMAIN I: INITIATING

Domain	Initiating (13%)
Task 1	Perform project assessment based upon available information, lessons learned from previous projects, and meetings with relevant stakeholders in order to support the evaluation of the feasibility of new products or services within the given assumptions and/or constraints.
Task 2	Identify key deliverables based on the business requirements in order to manage customer expectations and direct the achievement of project goals.
Task 3	Perform stakeholder analysis using appropriate tools and techniques in order to align expectations and gain support for the project.
Task 4	Identify high level risks, assumptions, and constraints based on the current environment, organizational factors, historical data, and expert judgment, in order to propose an implementation strategy
Task 5	Participate in the development of the project charter by compiling and analyzing gathered information in order to ensure project stakeholders are in agreement on its elements.
Task 6	Obtain project charter approval from the sponsor, in order to formalize the authority assigned to the project manager and gain commitment and acceptance for the project.
Task 7	Conduct benefit analysis with relevant stakeholders to validate project alignment with organizational strategy and expected business value.
Task 8	Inform stakeholders of the approved project charter to ensure common understanding of the key deliverables, milestones, and their roles and responsibilities.

PERFORMANCE DOMAIN II: PLANNING

Domain	Planning (24%)
Task 1	Review and assess detailed project requirements, constraints, and assumptions with stakeholders based on the project charter, lessons learned, and by using requirement gathering techniques in order to establish detailed project deliverables.
Task 2	Develop a scope management plan, based on the approved project scope and using scope management techniques, in order to define, maintain, and manage the scope of the project.
Task 3	Develop the cost management plan based on the project scope, schedule, resources, approved project charter and other information, using estimating techniques, in order to manage project costs.
Task 4	Develop the project schedule based on the approved project deliverables and milestones, scope, and resource management plans in order to manage timely completion of the project.
Task 5	Develop the human resource management plan by defining the roles and responsibilities of the project team members in order to create a project organizational structure and provide guidance regarding how resources will be assigned and managed.
Task 6	Develop the communications management plan based on the project organizational structure and stakeholder requirements, in order to define and manage the flow of project information.
Task 7	Develop the procurement management plan based on the project scope, budget, and schedule, in order to ensure that the required project resources will be available..
Task 8	Develop the quality management plan and define the quality standards for the project and its products, based on the project scope, risks, and requirements, in order to prevent the occurrence of defects and control the cost of quality.
Task 9	Develop the change management plan by defining how changes will be addressed and controlled in order to track and manage change.
Task 10	Plan for risk management by developing a risk management plan; identifying, analyzing, and prioritizing project risk; creating the risk register; and defining risk response strategies in order to manage uncertainty and opportunity throughout the project life cycle.
Task 11	Present the project management plan to the relevant stakeholders according to applicable policies and procedures in order to obtain approval to proceed with project execution.
Task 12	Conduct kick-off meeting, communicating the start of the project, key milestones, and other relevant information in order to inform and engage stakeholders and gain commitment
Task 13	Develop the stakeholder management plan by analyzing needs, interests, and potential impact in order to effectively manage stakeholders' expectations and engage them in project decisions.

PERFORMANCE DOMAIN III: EXECUTING

Domain	Executing (31%)
Task 1	Acquire and manage project resources by following the human resource and procurement management plans in order to meet project requirements
Task 2	Manage task execution based on the project management plan by leading and developing the project team in order to achieve project deliverables.
Task 3	Implement the quality management plan using the appropriate tools and techniques in order to ensure that work is performed in accordance with required quality standards.
Task 4	Implement approved changes and corrective actions by following the change management plan in order to meet project requirements.
Task 5	Implement approved actions by following the risk management plan in orde to minimize the impact of the risks and take advantage of opportunities on the project.
Task 6	Manage the flow of information by following the communications plan in order to keep stakeholders engaged and informed.
Task 7	Maintain stakeholder relationships by following the stakeholder management plan in order to receive continued support and manage expectations.

PERFORMANCE DOMAIN IV: MONITORING AND CONTROLLING

Domain	Monitor and Controlling (25%)
Task 1	Measure project performance using appropriate tools and techniques in order to identify and quantify any variances and corrective actions.
Task 2	Manage changes to the project by following the change management plan in order to ensure that project goals remain aligned with business needs.
Task 3	Verify that project deliverables conform to the quality standards established in the quality management plan by using appropriate tools and techniques to meet project requirements and business needs.
Task 4	Monitor and assess risk by determining whether exposure has changed and evaluating the effectiveness of response strategies in order to manage the impact of risks and opportunities on the project.
Task 5	Review the issue log, update if necessary, and determine corrective actions by using appropriate tools and techniques in order to minimize the impact on the project.
Task 6	Capture, analyze, and manage lessons learned, using lessons learned management techniques in order to enable continuous improvement
Task 7	Monitor procurement activities according to the procurement plan in order to verify compliance with project objectives

PERFORMANCE DOMAIN V: CLOSING

Domain	Closing (7%)
Task 1	Obtain final acceptance of the project deliverables from relevant stakeholders in order to confirm that project scope and deliverables were achieved.
Task 2	Transfer the ownership of deliverables to the assigned stakeholders in accordance with the project plan in order to facilitate project closure
Task 3	Obtain financial, legal, and administrative closure using generally accepted practices and policies in order to communicate formal project closure and ensure transfer of liability.
Task 4	Prepare and share the final project report according to the communications management plan in order to document and convey project performance and assist in project evaluation.
Task 5	Collate lessons learned that were documented throughout the project and conduct a comprehensive project review in order to update the organization's knowledge base
Task 6	Archive project documents and materials using generally accepted practices in order to comply with statutory requirements and for potential use in future projects and audits.
Task 7	Obtain feedback from relevant stakeholders using appropriate tools and techniques and based on the stakeholder management plan in order to evaluate their satisfaction.

Note: It is important to know the target of each task. And remember the correct order of tasks specially Initiating, executing and closing. Will help you answer some related questions in the exam

Disclaimer

All the information in this document were based and taken from PMBOK 6th edition by PMI. This is summary based on it to help revising for the exam.

This summary was prepared to help studying and revising for the PMP exam. However, It’s recommended to read the PMBOK 6th edition to be fully prepared for the exam. Because it mainly depends on your full understanding of the processes and how they interact with each other.

Good luck

Ahmed Hassan

For Support
BTC

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