Project Work

Project Management

Planning and Control

Anastasia Balabushevich
Claudia Casetti
Maria Greco
Simone Rodolfi

Eni Corporate University - Scuola Mattei
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CHAPTER 1

THE PROJECT MANAGEMENT

1 THE PROJECT MANAGEMENT

Project management, in its modern form, has been a recognized profession since about the 1950s, but project management as a special approach to organize efforts and resources and in some form has been going on as long as people have been doing complex work. When the Great Pyramids in Egypt were built, somebody somewhere was tracking resources, schedule, and the specifications for the final deliverable. Much later, in the early 1870s, during the construction of the first large transcontinental railroad, business leaders found themselves faced with the daunting task of organizing the manual labor of thousands of workers and the manufacturing and assembly of unprecedented quantities of raw material. And project management was used again to resolve all these problems.

But at that time there was no any idea about project management as an area of knowledge, as a strategic competency and as a special way of organizing people and a methodology of planning and controlling of their activity, aimed at achieving the well-defined end. And only near the turn of the century, Frederick Taylor (1856–1915) began his detailed studies. He applied scientific reasoning to work by showing that labor can be analyzed and improved by focusing on its elementary parts. Before, the only way to improve productivity was to demand harder and longer hours from workers. He was the first one to see the benefit of organizing work around projects and to understand the critical need to communicate and integrate work across multiple groups and divisions, so-called “project teams”.

Taylor's associate, Henry Gantt (1861–1919), studied in great detail the order of operations in work. His studies of management focused on Navy ship construction during World War I. His Gantt charts, complete with task bars and milestone markers, outline the sequence and duration of all tasks in a process. Gantt chart diagrams proved to be such a powerful analytical tool for managers that they remained virtually unchanged for nearly a hundred years.

Taylor, Gantt, and others helped evolve management into a distinct business function that requires study and discipline. In the decades leading up to World War II, marketing approaches, industrial psychology, and human relations began to take hold as integral parts of business management. This view of business as a human organism has remained till nowadays. It implies that in order for a business to survive and prosper, all of its functional parts must work in concert toward specific goals, or projects.

Project management approach is actually used not only for the large industrial or infrastructure tasks, as it was before, but to the most various aims, such like the events’ planning and organization. But the idea and the scope of the project management are still the same: to meet the client requests, to respect the time and to keep the costs within the budget. All these projects, regardless of their dimensions and deliverables, share a common underlying structure (especially for larger businesses): that the project is managed by a project manager, who puts together a team and ensures the integration and communication of the workflow horizontally across different departments.

1.1 The notion of project

Prior to pass to the main part of this work we believe that it should be useful to understand what defines a project and project management and distinguish them from ongoing operations.

There are many and varying definitions of the term “project”. But the commonly used one is given by The Project Management Institute (PMI®) that stands as a global leader in the field of project management. Therefore the present work in its approach to project planning and control will mainly follow the PMBOK procedures and also ENI’s guidelines.

According to PMI “a project is a temporary endeavor undertaken to create a unique product or service”[1]. It means that the project should by temporary, should have a unique deliverable, created through the planned and leaded process of team work.

Thereupon, **temporary** signifies that every project has a definite beginning and a definite end. Project is a process of progressive elaboration and step improvements. Therefore projects are not the same as ongoing operations, although the two have a lot in common. Ongoing operations, as the name suggests, go on indefinitely; and an end date is not established. And projects are distinguished from ongoing operations by an expected end date, such as the date of the recruiting fair.

Unique means that the fundamental objective of every project is to deliver something new. In other words, the final deliverable (product or service) should be different in some distinguishing way from all other products or services.

The project implementation requires a **team work**. Project is always performed by people and therefore needs an organization and clear definition of roles and responsibilities.

Project is something **planned**. The endeavor is undertaken by a team or an organization, so projects have a sense of being intentional, planned events. Successful projects don't happen spontaneously; some amount of preparation and planning happens first.

One more feature of the project is that it is **constrained by limited resources.** Every project has constraints. And the primary ones are the tradeoff between Time, Resources and Performance Criteria.

The Performance Criteria (the scope of the project) are the things the project will deliver and to what quality standard they will be delivered. Project scope is the combination of all project goals and tasks, and the work required to accomplish them. And one of the main reasons for producing a well defined Project Definition is to ensure that the Performance Criteria are set and agreed.

There are two aspects of scope: product scope and project scope. **Product scope** is a tangible item or a service. Product scope describes the intended quality, features, and functions of the product— often in minute detail. Documents that outline this information are sometimes called product specifications. A service or an event usually has some expected features as well.

[1] *Project Management Body of Knowledge (PMBOK Guide), third edition*

Project scope, on the other hand, describes the work required to deliver a product or a service with the intended product scope. Whereas product scope focuses on the customer or the user of the product, project scope is mainly the concern of the people who will carry out the project.

Resources (project costs) are people, equipment and money. They may be internal or external and include suppliers, contractors, partners, statutory bodies, governments, banks, loans, grants, expert opinion (Lawyers, Accountants, Consultants), etc. The main idea is that the project cost has a broader meaning: costs include all the resources required to carry out the project. For virtually all projects, cost is ultimately a limiting constraint; few projects could go over budget without eventually requiring corrective action.

Time criteria is a time to complete the project. Limited time is the one constraint of any project. A restriction set on the start or finish date of a task. You can specify that a task must start on or finish no later than a particular date. Constraints can be flexible (not tied to a specific date) or inflexible (tied to a specific date). A project's duration might be just a week, or it might go on for years, but every project has an end date. And to complete the project by the time means to respect all target dates and deadlines.

The constraints on the project are one form of risk. In other words, a risk is anything that will have a negative impact on any one or all of the primary project constraints - **Time, Resources and Performance Criteria**.

To complete the project in the **shortest time** means that overtime costs may soar and quality and safety may be impacted. To complete the project at the **lowest cost** presumes the duration and quality may be impacted. To achieve the **best quality** results duration and cost may be impacted. To achieve the **highest safety**, costs may be impacted.

And one of the main tasks of project management is to balance the time, cost, and scope constraints of the project. And there are **three concepts of tradeoff** between these project's objectives.

The first one is based on **the project triangle** that illustrates the process of balancing constraints because the three sides of the triangle are connected, and changing one side of a triangle affects at least one other side. If the duration (time) of the project schedule decreases, one needs to increase budget (cost) to hire more resources to do the same work in less time. If it's impossible to increase the budget, it's necessary to reduce the scope because the primary resources can't do all of the planned work in less time and so on.

According to the second concept of project objectives there are four core project management parameters and they are scope, quality, time and cost arranged in a square and not a triangle. The third concept represents the mix of the two previous ones. It stands that Quality, a fourth element, is at the center of the project triangle. It means that changes you make to any of the three sides of the triangle are likely to affect quality. Quality is not a side of the triangle; it is a result of what you do with time, cost and scope. Thus, this theme has many variations, but the basic idea is that every project has some element of a time constraint, has some type of budget, and requires some amount of work to complete. In other words, it has a defined scope to achieve using the feasible resources and responding to emerging external and internal changes. And in the end it's not important what concept is used. The message is that managing the **time-cost-scope tradeoff** with skill and understanding is a very important part of managing a project as a

whole. Therefore, the project manager and his team, in the course of managing the project process, must choose options and make decisions according to such priorities.

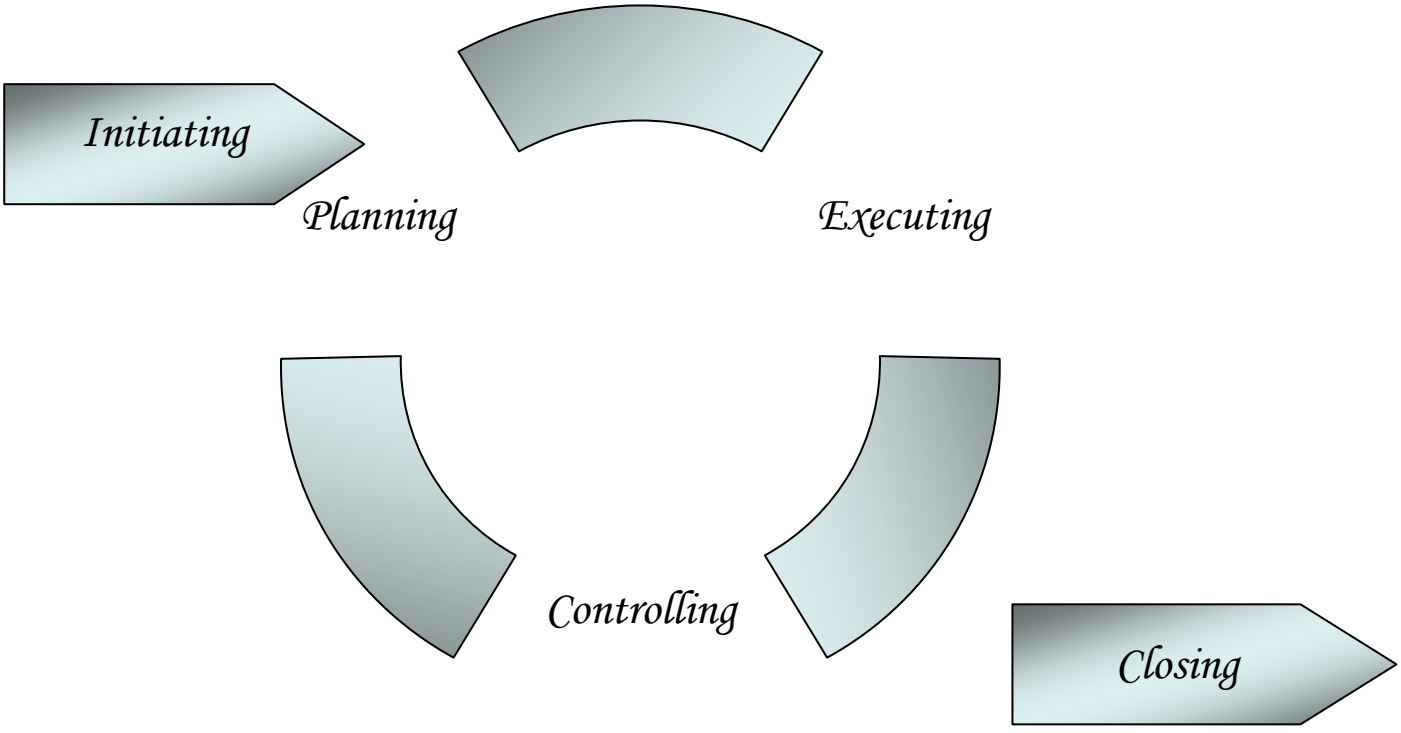
1.2 The notion of project management

According to PMI "Project management is the application of knowledge, skills, tools and techniques to project activities to meet project requirements"[2].

And as it was stated above a manager can and has to control four things:
- Resources (can use more or less facilities, personnel and so on)
- Time (can increase schedule, delay milestones)
- Scope (Scope of the project but only with the priorities, indicated by Client/Sponsor)
- and also Risk (can decide which risks are acceptable)

1.3 The project management process

The core **project management process** is divided into five main stages that correspond to the project life cycle: The core **project management process** is divided into five main stages that correspond to the project life cycle:



1.3.1 Initiating

[2] *Project Management Body of Knowledge (PMBOK Guide), third edition*

Initiating means authorizing and setting up the project or phase. Usually at the start of any project, there is a variety of ideas and opinions about the purpose and scope of the project, what the final product of the project will be, and how the project will be carried out. The Project Initiation Step is concerned with taking these ideas and intentions and developing them into a formal, planned, resourced and funded project.
Clear and accurate definition of a project is one of the most important actions to ensure the project's success. But the definition of the project means a statement of the problem, not the solution. The outcome of this initiating phase should be a *written* definition of what is required, by when; and this document must be *agreed* by all involved.

1.3.2 Planning

Planning is defining and refining objectives and selecting the best alternative to attain the objectives that the project was undertaken to address. Project planning includes development of the overall project structure, the activities and work plan/timeline that will form the basis of the project management processes employed throughout the project lifecycle. Thorough Project Planning provides the structure and procedures to ensure that adequate time and effort is put into identifying the project scope, deliverables, resource requirements, and risks.
The Planning Process also sets out procedures that will be used within the project for tracking progress, using tools and methodologies, communicating with the project team members, users and other stakeholders, resolving issues and problems, acceptance, performance reporting and addressing change requests.

1.3.3 Controlling

Controlling means ensuring that project objectives are met by monitoring and measuring progress regularly to identify variances from plan so that corrective action can be taken when necessary. And project control process is required to evaluate the work done (feedback view) and to forecast the remaining work to complete the project scope of work. In the circumstances time and cost are always critical and require special attention. These two important objectives can be controlled through detailed Schedule and Cost Control, examined in the respective charter of this work.

1.3.4 Closing

Closing represents formalizing acceptance of the project or phase and bringing it to an orderly phase.
By this time, all project work should have been completed, and the products of the project should have been accepted by the customers. It is possible however, that the final products do not fully meet the original objectives and requirements.
During this step all documents, reports and so on should be formally closed. All leanings should be captured for future use and all the information generated during a project should be stored.

1.4 The project management areas of expertise

Much of the knowledge and many of the tools and techniques for managing project are unique to project management, such as work breakdown structures or critical path analysis. However, understanding and applying the knowledge , skills, tools and techniques, are not sufficient alone for effective project management. Effective project management requires that the project management team understand and use knowledge and skills from at least five areas of expertise:

- ***The Project Management Body of Knowledge***: The project management body of knowledge describes knowledge unique to the project management disciplines. The knowledge of project management consists of project life cycle definition, project management process groups and ***knowledge areas***.

- ***Application area knowledge, standards, and regulations:*** Application areas area usually defined in term of functional departments (legal, production, logistics, etc),technical elements (software development or engineering, etc), management specializations (government contracting, etc) or industry groups (automotive, chemical, financial service, etc). Each application area generally has a set of accepted standards and practices, often codified in regulation.

- ***Understanding the project environment:*** The project team should consider the project in its cultural, social, international, political and physical environmental contexts.

- ***General management knowledge and skills:*** General management encompasses planning, staffing, executing and controlling the operations of an ongoing enterprise. On any given project, skill in any number of general management areas may be required.

- ***Interpersonal skills:*** Interpersonal skills are leadership, motivation, problem solving, etc.

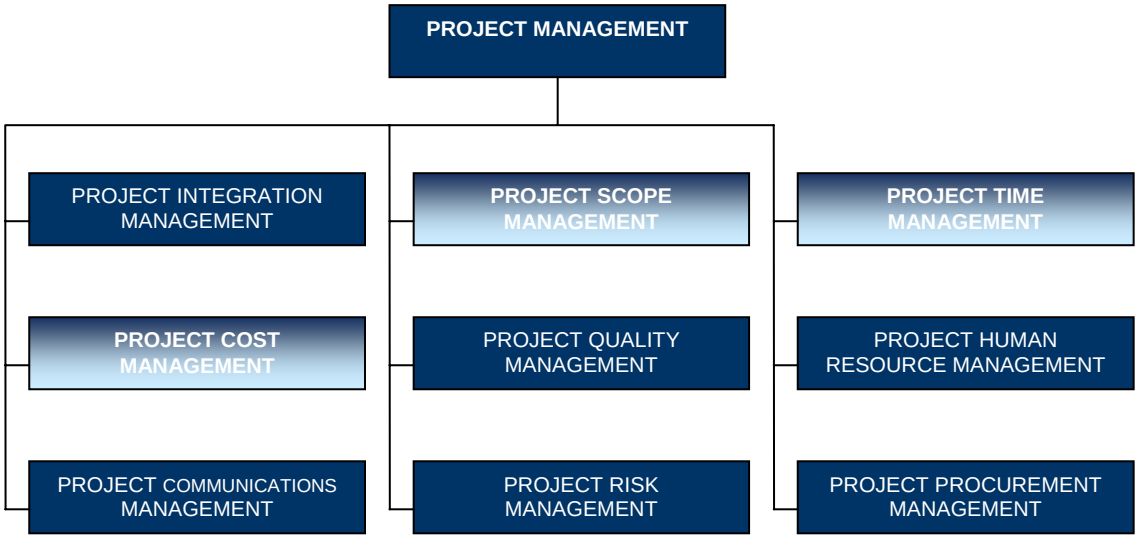
Although they appear as discrete elements, they are generally overlap and none can stand alone.

1.5 The project management knowledge areas

The project management knowledge areas organizes project management processes into nine[1] knowledge areas, as described below.

- ***Project Integration Management*** describes the processes and activity that integrate the various elements of project management, which are identified, defined, combined, unified and coordinated within the project management process.
- ***Project Scope Management*** describes the processes involved in ascertaining that the project includes all the work required, and only the work required, to complete the project successfully.
- ***Project Time Management***: describes the processes concerning the timely completion of the project.

- ***Project Cost Management*** describes the processes involved in planning, estimating, budgeting, and controlling costs so that the project is completed within the approved budget.
- ***Project Quality Management*** describes the processes involved in assuring that the project will satisfy the objectives for which it was undertaken.
- ***Project Communications Management*** describes the processes concerning the timely and appropriate generation, collection, dissemination, storage and ultimate disposition of project information.
- ***Project Human Resources Management*** describes the processes that organize and manage the project team.
- ***Project Risk Management*** describes the processes concerned with conducting risk management on a project.
- ***Project Procurement Management*** describes the processes that purchase or acquire products, services or results, as well as contract management processes.



All the project management processes apply to the different knowledge areas, but in this document the focus is on the application of the planning and contol cycles to the time and cost knowledge areas. The document is aimed at illustrating and analyzing the planning, monitoring and controlling processes in three major project manager areas: scope definition, time and cost.

[1] *Project Management Body of Knowledge (PMBOK Guide), third edition*

1.6 Project Planning and Controlling

1.6.1 Project Planning

Once the objective and scope are decided, it is necessary to determine which activities are required to be carried out to meet the objective. The dependencies between these activities can then be determined, which in turn allows resources and timescales to be estimated.

This needs to be done for the whole project and this step is called the Project Planning when the Project Budget and Progress Scheduling should be defined.

Once this has been done, it is necessary to estimate the resources, both client and technical, required for the project. It should cover all personnel resources required, both full and part time. The requirements for other types of resource, such as office space and equipment, should also be determined. A time line and cost estimate for the project can then be developed.

1.6.2 Monitoring and Controlling

There is some difference between monitoring and controlling activities.

Monitoring a project means to collect project performance data with respect to a planned baseline, produce performance measures and report this information.

Controlling a project means to compare actual performance with planned performance to find variances, then assess trends to effect process improvements, to evaluate possible alternatives, and if needed, choose from them an appropriate corrective action.

Monitoring and controlling is the routine adjustment of activities to ensure the project meets its authorized duration, cost and quality or performance. Monitoring and controlling are activities necessary to provide feedback on the health of the project, to enable corrective actions to be taken, to ensure objectives can be met and benefits will be realized.

As monitoring involves measuring, then comparing, and finally evaluating the work done, it is a passive process: the past can not be changed. Conversely, controlling uses the evaluations made during the monitoring process to make predictions and then act, eventually re-plan. Controlling is concerned with piloting the remaining work and, as future can be controlled, this is an active process.

Summing up, the monitoring and controlling process consists of:

- monitoring the ongoing project activities against the project management plan and the project performance baseline;
- influencing the factors that could circumvent integrated change control so only approved changes are implemented.

This continuous monitoring provides the project team insight into the health of the project and highlights any area that require additional attention.

The monitoring and control process requires to establish the up to date situation and to compare it versus a reference one, called baseline. It represents a realistic prediction of job execution, it is the original approved plan in terms of a set of dates and costs frozen at the start of the project. It should be sufficiently detailed, but not excessively specific, so as to reflect the average performance. It is needed before commitments are made.

The measures made during the monitoring process are about:

- time: achievement dates of deliverables, and supplier or external dependencies dates;
- cost: effort expressed in man-days, and commitments of external expenditure
- quality: process assurance and product quality controls;
- risk: to ensure that risks are identified early, their status is reported, and appropriate risk plans are executed

The project team should define when to observe and measure the project performance to identify variances from the project management plan. The control process is to be carried out on a regular basis along the project lifecycle and performed at the end of the project to capture the knowledge experienced. It is very important to detect problems early, as costs and efforts of making a distinct change grow exponentially with the development of the project.

There are various methods of gathering information: passive, active, formal and informal.

The passive method consists of waiting and see what happens, so it is absolutely not recommended.

A manager should use the active method, summed up by the acronym MBWA, which stands for Management By Walking About. The manager should not stay in its office and wait for a report, but should see personally how the work is conducted and speak with the working team, providing feedback, resolving issues, and coordinating changes to enhance project performance

Progress meetings and problem meetings are formal ways for gathering information, but also informal discussions may be helpful. They are attended by the key managers or team leaders only. As it must be brief, usually not longer than half an hour, it should be conduced with an agenda summing all the points to be discussed. During this meeting current or future problems are only identified, not solved. It is important to ensure that everybody really agrees on the problems identity, and then it is elected an individual responsible for solving each problem, within a target deadline. A written action assignment should follow within 24 hours covering points discussed and conclusions reached.

To compare and evaluate schedule and cost variance, it is widely used the Earned Value Analysis, which will be thoroughly explained later on this paper. Here we will just say that it consists on comparing the budgeted cost of work performed with the budgeted cost of work scheduled to highlight schedule variance; and to compare budgeted cost of work scheduled with actual cost of work performed to evaluate cost variance.

The control process requires taking decisions which affect the final project outcome. Predictions are crucial and, as better forecasts produce better decisions, it is recommended to produce alternatives and think them through.

It is usual to divide the project into phases, which are known as the project life cycle. This allows a better control, linking the ongoing operations to the performing organization. Project life cycles usually define, together with the deliverables and responsibilities, also how to control and approve each phase. For effective control, each phase is formally

initiated to produce a phase-dependent output, specifying what is allowed and expected for that phase. In multi-phase projects the plan-do-check-act circle also provides feedback between project phases, in order to implement corrective or preventive actions to bring the project into compliance with the project management plan. This review can result in recommended updates to the project management plan. For example, a missed activity finish date can require adjustments to the current staffing plan, reliance on overtime, or tradeoffs between budget and schedule objectives.

The monitor and control process is consistent with a commitment to continuous improvement : the plan-do-check-act cycle is the basis for quality improvement (as defined by Shewhard and modified by Deming, in the ASQ Handbook, 1999, pages 13-14), where quality is “ the degree to which a set of inherent characteristics fulfill requirements”. The project manager is responsible for delivering the required levels of both quality and grade of technical features.

CHAPTER 2

THE PROJECT ORGANIZATION

2 THE PROJECT ORGANIZATION

Projects are typically part of an organization and the maturity, the style and the culture of the organizational structure can influence the project.
Project are means of organizing activities that cannot be addressed within the organization's normal operational limits. The purpose of a project is to attain its objective and then terminate.
Projects are undertaken at all levels of the organization and they can involve a single person or many thousands.
Their duration ranges from a few weeks to several years. Projects can involve one or many organizational units.
Example of project are developing a new product or service, effecting a change in structure, designing a new transportation vehicle, constructing a building or facility, implementing a new business procedure or process, etc... .

Project are, therefore, often utilized as a means of achieving an organization's strategic plan and they are typically authorized as a result of a market demand, an organizational need, a customer request, a technological advance, a legal requirement.

2.1 Organizational structure

Project management organizational structure can have a significant impact on the success of any project.
Choice of the organizational structure will depend on factors such as size, content, complexity, distribution of the project, company's culture and organization. Success of any organization is not only a function of the capabilities of the individuals but it strongly depends on the way in which they are organized.
Organization perform work to achieve a set of objectives. Generally, work can be categorized as either projects or operations. Projects and operations share many characteristics: performed people, constrained by limited resources, planned, executed and controlled.
The structure of performing organization often constrains the availability of resources.
The most well known organizational structures are projectized, functional, matrix.
The table shows how the major types of project organizational structures influence project characteristics.

Organization Structure / Project Characteristics	Functional	Matrix			Projectized
		Weak	Balanced	Strong	
Project Manager's authority	Little o none	Limited	Low- Moderate	High- Moderate	High
Resource availability	Little o none	Limited	Low- Moderate	High- Moderate	High
Who controls the project budget	Functional Manager	Functional Manager	Mixed	Project Manager	Project Manager
Project Manager's role	Part time	Part time	Full time	Full time	Full time
Project Management administrative staff	Part time	Part time	Part time	Full time	Full time

Type of organizations can be characterized by the level of Project Manager's authority are:

- *Projectized*
- *Strong Matrix*
- *Weak Matrix*
- *Functional*

Project Manager has maximum authority in a projectized organization and least authority in a functional organization.

2.2 Functional structure

In functional organizations staff is organized based upon their specialty, such as engineering or sales. Each specialty may be further subdivided into smaller functional organizations for example engineering may be subdived in mechanical and electrical.
Functional structures are not flexible and are used when the organization is small, geographically centralized, and provides few goods and services.
This organization reduces duplication of activities, encourages technical expertise, but it is difficult to coordinate because the scope of the project is usually limited to the boundaries of the function and each specialty works independently.
In these organizations, functional managers are responsible for specialized departments like marketing or engineering. In functional organization, the role of Project Manager is limited: the line of authority normally goes from the project manager, through a functional manager, to the project team member; so the project manager's direct authority over the project team is limited.

Advantages of the Functional Organization

- Flexibility in the staff use
- Knowledge and experience readily shared between functional specialists
- Technical continuity exists within the organization
- Good technology transfer between projects
- Clearly defined professional growth and career paths for the staff
- Efficient use of technical personnel
- Career continuity and growth for technical personnel
- Good stability

Disadvantages of the Functional Organization

- Weak customer interface
- Response to customer needs is slow and difficult
- Not focused on solving project business issues
- Weak project authority
- Project does not have a single individual responsible for all aspects of the project
- Project issues are not given the same level of attention
- Discipline rather than program oriented
- Poor horizontal communication
- Slower work force

2.3 Projectized organization

Opposite from functional structure is projectized organization where team members are often collocated.
In projectized organization, Project Managers have more authority and independence; all the persons in the project team report to the Project Manager.
Most of the organization's resources are involved in project work, and project managers have a great deal of independence and authority.
The projectized organization typically includes dedicated, full time team members with different skill sets that stay together, as a cohesive unit, for the life of the project.

Advantages of the Projectized Organization

- Clear lines of authority, the project manager has full authority
- Response to customer and stakeholder issues is faster and clearer
- Skilled project team can support several successive projects of the same type
- Timely decision-making
- Organizational structure is simple, flexible, and easy to understand
- Simpler project communication
- Good project schedule and cost control
- Training ground for general management

Disadvantages of the Projectized Organization

- Inefficient use of specialists: expensive approach because of the duplication of personnel
- Equipment and personnel may be organized to ensure access to those resources
- Team members lose access to a repository of functional or technical expertise
- Uncertain technical direction
- Policies and procedures are often applied inconsistently
- Team members are insecure regarding future job assignments

2.4 Matrix organizations

Real situations are a mixture of functional and projectized organizations: matrix organization. Most modern organizations involve all this structure at various levels.
It is an organization in which project team members are “borrowed” from their functional organizations to work on a specific project and then returned once their part of the project has been completed or their skills are no longer needed. For example, even a fundamentally function organization may create a special project team to handle a critical project. Such a team may have many of the characteristics of a project team in a projectized organization.
The team may include full-time staff from different functional departments, may develop its own set of operating procedures and may operate outside the standard, formalized reporting structure.
There are three different types of matrix organizations:

- *Weak Matrix*: Similar to functional hierarchies in which a project manager borrows an employee from a functional discipline to do work on a project. The project manager’s responsibilities are: more coordination and expedition than actual management.
- *Balanced Matrix*: A combination of weak and strong matrix organizations. In a balanced matrix, the project manager borrows staff from a functional organization on an as needed basis. The borrowed staff works directly for the project manager until their project tasks are completed. In this model, the project manager has authoritative power over management of the project effort.
- *Strong Matrix*: Similar to projectized organizations. In the strong matrix organization, a project manager has a full time staff borrowed from functional disciplines for the duration of the project. In this model, the project manager has full authoritative power over management of the project effort and the people assigned to the project.

Advantages of the Matrix Organization

- Is the project central focus
- Project managers have access to a large reservoir of technically skilled people
- Project team members have less anxiety about the future
- Customer issues are responded to quickly
- Administrative personnel are not duplicated in each project team
- Resource balancing between projects is simpler and more efficient
- Project team organization is more flexible

Disadvantages of the Matrix Organization

- Person with decision making power is not always clearly identified
- Resource balancing between projects can lead to friction
- Project closeout tasks are often difficult in strong matrix organizations
- Division of authority and responsibility is complex

2.5 Organizational systems, cultures and styles

The project management team should be aware of how its organization's structure and systems affect the project.
There are two categories of organizational systems: project based organizations and non project based organizations.
Project based organizations fall into organizations that derive their revenues from performing projects (architectural firms, engineering firms...) and organizations that have adopted management by project. An organization that adopts this approach defines its activities as projects that influence all organizational levels.
There has been a tendency in recent years to manage more activities in more application areas using "management by project". The adoption of "management by project" is also related to the adoption of an organizational culture that is reflected in shares value, norms, policies and procedures, view of authority relationships, work ethic, etc.
Organizational cultures often have a direct influence on the project. A project manager with a highly participative style is adapt to encounter problems in a rigidly hierarchical organization, while a project manager with an authoritarian style will be equally challenged in a participative organization.
Non project based organizations often may lack management systems designed to support project needs efficiently and effectively. The absence of project oriented systems usually makes project management more difficult. In some cases there are special support units that operate as project based organization.

2.6 Roles and responsibilities

To ensure project success, the project management team must identify stakeholders early in the project, determine their needs and expectations, and manage and influence those expectations over the course of the project. Clearly defined project team members roles and responsibilities provide each individual, associated with the project, with a clear understanding of the authority granted and single responsibility for the successful accomplishment of project activities.
Project team members must be accountable for the effective performance of their assignments.

- On a large project, individual role assignments may require full-time attention to a particular function.
- On smaller projects, role assignments may be performed part-time, with stakeholders sharing in the execution of multiple functions.

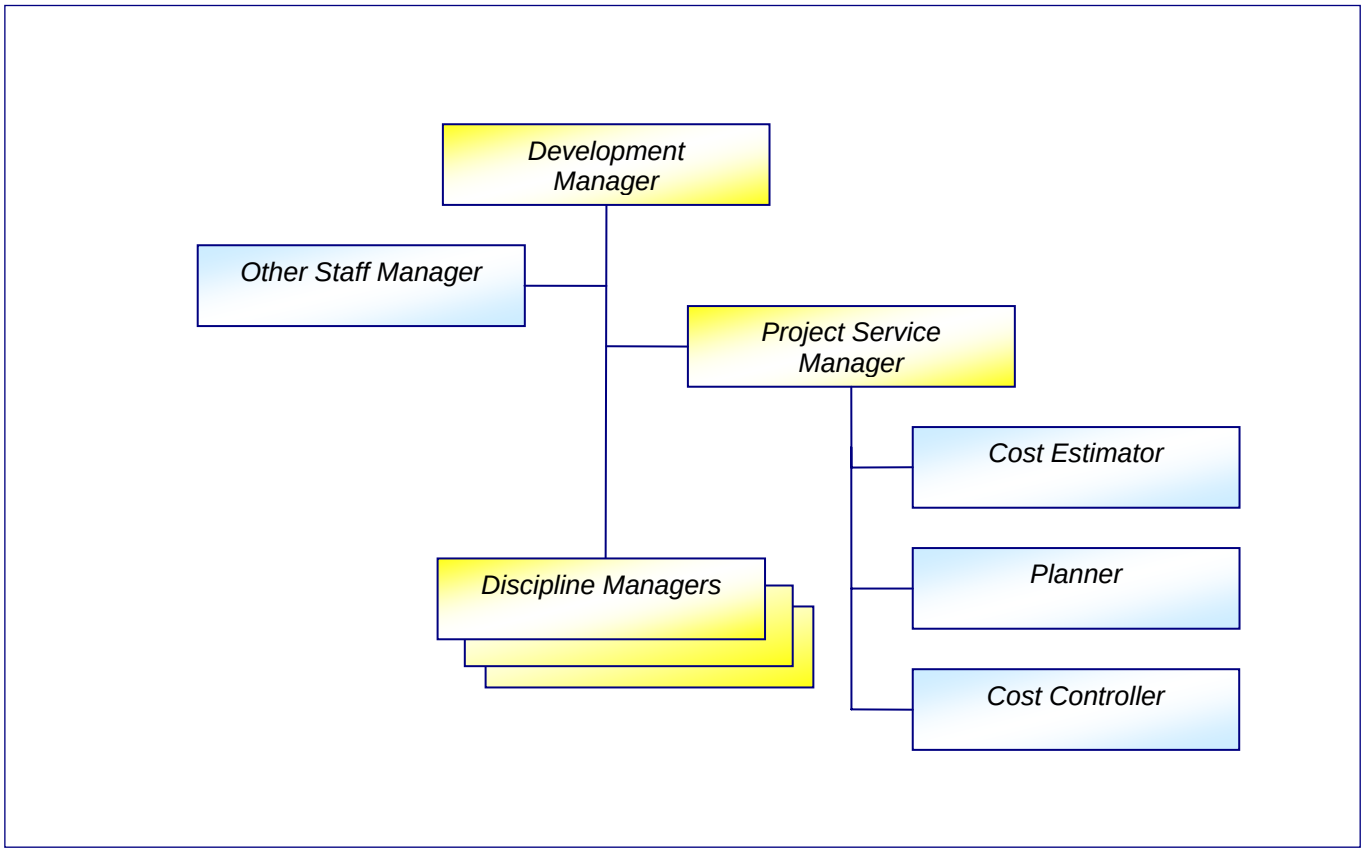
The identification of specific team members tasks is addressed in the Organizational Breakdown Structure (OBS). The O.B.S. represents the organization of the project, identified assigning the responsibility to each work package of the WBS: the responsibility assignment may be structure in a Responsibility Matrix
Key project team members include (but are not limited to) the:

- ***Project Manager*** - The project manager is an individual appointed and given responsibility for management of the project. The project manager must ensure that the project is successfully executed, completed on time, within budget, and at an acceptable level of quality. There is a main difference between the discipline managers, who execute the technical and functional activities to realize the project scope, and the project service managers, who are in charge of planning and controlling activities.

- ***Project Team (Staff)*** - The project team includes those individuals that report, either part time or full time, to the project manager and are responsible for the completion of project tasks. The project team includes subject matter experts responsible for executing the project plan.

The project team includes those individuals that are responsible for the completion of project tasks and subject matter experts responsible for executing the project plan.
A typical project organization chart is the following[2]:

[2] *The team members job description are illustrated in attachment n. 1*


Development Manager
Other Staff Manager
Project Service Manager
Cost Estimator
Discipline Managers
Planner
Cost Controller

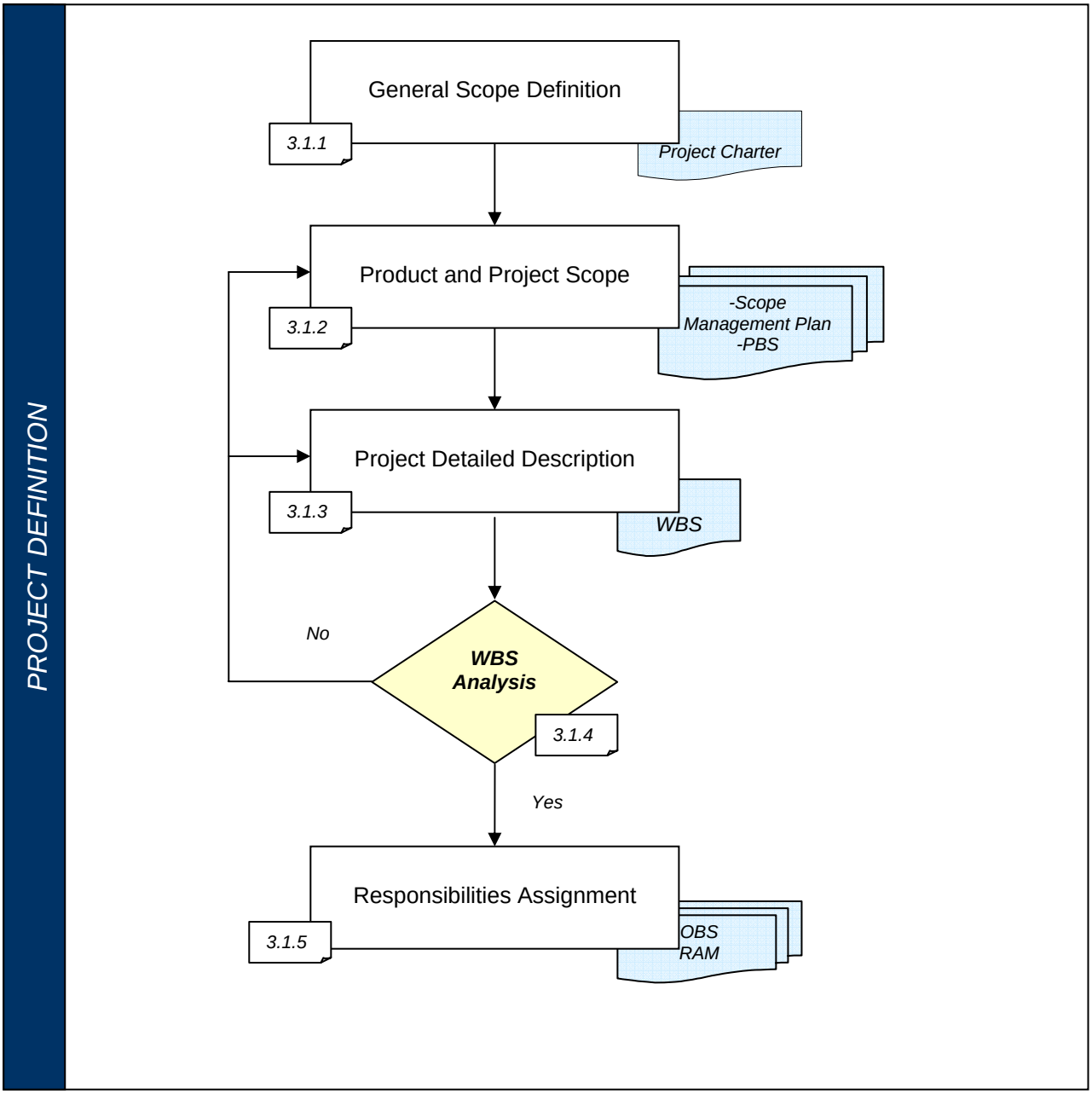
CHAPTER 3

WORKFLOWS

3 WORKFLOWS

3.1 Project definition

This is the process necessary for developing a project scope management plan that documents how the project scope will be defined, how the Work Breakdown Structure (WBS) will be created and controlled, and how the responsibilities will be assigned.



3.1.1 General scope definition

This step provides a preliminary high-level definition of the content of the project. Starting from information provided by the initiator or sponsor, it focuses on "why" the project is to be accomplished. Sponsor and Project Manager should define the boundaries and the constrains of the project, as well as the objectives, requirements and characteristics of the products and services to be produced. In this phase it is also recommended to establish in a general manner the organization, risks, order of magnitude of costs and time, acceptance criteria of the project. Furthermore, it is necessary to find out all the stakeholders of the project and to segment them accordingly to their influence and to their interest on the project. The output of this phase is a project charter that illustrates the project requirements and links the project to the ongoing work of the organization, so
a knowledge of the company organizational systems and of its structure is essential for the correct development of the project charter.

INPUT

3.1.1.1 Project statement of work

The statement of work is a narrative description of the services and products that the project should develop; it is often provided by the client or sponsor and it is based on the product requirements as well as on the company's business needs, documenting the relationship among the deliverables being created and the stimuli that caused the needs.

3.1.1.2 Enterprise environmental factors

All the enterprise factors that surround and influence the project success must be analyzed and explicitly considered when the project charter is being developed. These factors include, but are not limited to:
- organization or company culture and structure
- government or industry standards
- existing human resources
- personnel administration
- marketplace conditions
- organizational corporate knowledge base for storing and retrieving information.

OUTPUT

3.1.1.3 Project Charter

The project charter is the document which formally authorizes the project. It is a formal statement of the business goals and benefits which the project will bring. It describes the business need that the project was taken to address and the characteristics of the product or service to be created. Key elements of he project charter are:
- requirements, business needs, high-level project description;
- project purpose or justification;
- assigned project manager and authority level;
- stakeholder involvement;
- organizational, environmental and external assumptions and constraints;
- summary milestone schedule and budget.

3.1.2 Product scope and project scope

The product scope identifies the final products of the project which must be delivered to achieve project success. Here are also decided the features and functions of these products. The final products are further subdivided into deliverables. Among all deliverables, it is important to identify the major ones. These major deliverables are often predecessor deliverables that are needed to build what has been committed to, but that in themselves do not satisfy a business need. The project scope is a definition of the organization, risks, costs and time of a project made in the light of the definition of all the deliverables which will be produced. The development of the product and project scope and the detailing of it begin with the analysis of information contained in the project charter, historical information contained in the organizational process assets and any relevant enterprise environmental factor.

INPUT

3.1.2.1 *Enterprise environmental factors* (see section *3.1.1.2*)
3.1.2.2 *Project Charter* (see section *3.1.1.3*)

OUTPUT

3.1.2.3 *Product breakdown structure (PBS)*
The product breakdown structure is a document containing a hierarchical structure which breaks down the physical deliverables of the project into smaller components. It must not be confused with the WBS, which concerns activities, while the PBS concerns physical deliverables. All the major project deliverables are usually illustrated in the PBS being divided into minor components, every descending level of the structure representing smaller physical steps. The document is integrated by a PBS dictionary where the features and functions that characterize each deliverable are described. These features must also include the product acceptance criteria in terms of constraints and assumption that could limit the project management team's options.

3.1.2.4 *Scope management plan*
The scope management plan includes all the processes needed to ensure that the project includes all the work required and only the work required to be successfully completed. It is a planning tool describing how the team will define a detailed project scope description, develop the work breakdown structure, verify the project scope and control the project scope. This document may be formal or informal, rather general or detailed, according to project's needs; it contains indications on:
- the process to prepare a detailed project scope statement;
- the process to create, maintain and approve the WBS;
- the process necessary to approve the obtained deliverables;
- the process to manage requirements for changes in the project scope statement.

3.1.3 Project detailed description

In this phase the project objectives, boundaries, constraints and assumptions are accurately described and analyzed. All the work necessary to reach the project goals is identified and described in a way that provides a common understanding among all stakeholders; enables project team to perform detailed planning; guides the project team working during execution and provides a baseline for evaluating the work done and the resources employed. The degree and level of detail to which the document defines how and what work will be performed and what work will be excluded can determine how well the project management team can control the overall project development in term of planning, managing and controlling the execution. The project detailed description should illustrate directly or by reference to other documents:

- project objectives such as measurable success criteria that could include costs, schedule and quality targets;
- product scope description;
- project requirements describing conditions or capabilities that must be met or possessed by the deliverables of the project to satisfy a contract, standard, specification or other formally imposed documents;
- stakeholder analyses of all stakeholder needs, wants, and expectations translated into prioritized documents;
- project boundaries that state explicitly what is excluded from the project;
- project deliverables including both the outputs that comprise the product or service of the project, as well as ancillary results, such as project management reports and documentation;
- project constraints that limit team's options such as contractually provisions or any imposed date or predefined budget;
- project assumptions and their potential impact if they prove to be false;
- initial defined risks;
- initial organization;
- fund limitations.

INPUT

3.1.3.1 *PBS* (see section *3.1.2.3*)
3.1.3.2 *Scope management plan* (see section *3.1.2.4*)

OUTPUT

3.1.3.3 *Work breakdown structure (WBS) and WBS dictionary*

The work breakdown structure is a deliverable-oriented hierarchical decomposition of the work to be executed by the project team, to accomplish the project objectives and create the required deliverables. The WBS organizes and defines the total scope of the project subdividing the work into smaller, more manageable pieces of work with each descending level of the WBS representing an increasingly detailed definition of the project work. The planned work contained in the lowest level of the WBS components, which are called work packages, can be scheduled, cost estimated monitored, and controlled; the level of detail of work packages will vary with the size and complexity of the project. Different deliverables can have different levels of decomposition and as the work is decomposed to lower levels of detail, the ability to plan, manage and control is enhanced. However, excessive decomposition could lead to non productive management effort, inefficient use of resources and decreased efficiency in performing the work. Components comprising the WBS assist the stakeholders in viewing the deliverables of the project. Although each project is unique, a WBS from a previous project can often be used as a template for a

new project, since some projects will resemble another prior project to some extent. The work to create a complete WBS generally includes:
- analyze the PBS and identify major deliverables and related work;
- structure and organize a preliminary WBS;
- decompose the upper WBS level into lower level detailed components;
- develop and assign identification codes to the components;
- create a final WBS approved and understood by major stakeholders.

The resulting WBS structure can take different forms such as using as the first level of the decomposition the subprojects and the major deliverables or the phases of the project life cycle with the project deliverables inserted at the second level.
A document often generated to integrate and support the WBS is called the WBS dictionary and describes in detail the contents of components contained in the WBS, including work packages and control accounts. For each WBS component, the dictionary includes a code of account identifier, a statement of work, responsible organization, and a list of schedule milestones. Other information can include contract information, quality requirements, technical references, associated schedule activities, resource required and an estimate of cost. Each WBS component is cross referenced, as appropriate to other WBS components in the WBS dictionary.

3.1.4 WBS analysis

The WBS analysis is a decision point where it is discussed if the work breakdown structure crated in the previous step is appropriate or not. The WBS must be accepted and understood by all team members and project stakeholders, so the fundamental components of the structure should represent verifiable products, services, or results clearly and completely defined and assigned to a specific performing organizational unit. The decision point mainly analyze if the activities which make up the WBS are sufficient and not disproportionate to meet the sponsor's requirements illustrated in the project charter and if the work packages are correctly defined and understood. It also consider how activities belonging to different project phases are linked to each other, and if the deliverables and procedures that need more control and more team working are sufficiently detailed.

3.1.5 Responsibilities assignment

In this phase it is decided who is responsible for each work package of the WBS and the entire project organization is defined at a detailed level. Every projected work package shown in the WBS and described in the WBS dictionary require a different skills and knowledge and the person or team member responsible for each work package must be chosen according to its ability, its authority and
its capacity. The way in which the responsibilities are assigned should take into account the communication needs and all the different aspects involved in building an helpful and cooperative organizational structure.

INPUT

3.1.5.1 *Scope management plan* (see section *3.1.2.4*)

3.1.5.2 *WBS and WBS dictionary* (see section *3.1.3.3*)

OUTPUT

3.1.5.3 *Organization Breakdown Structure*

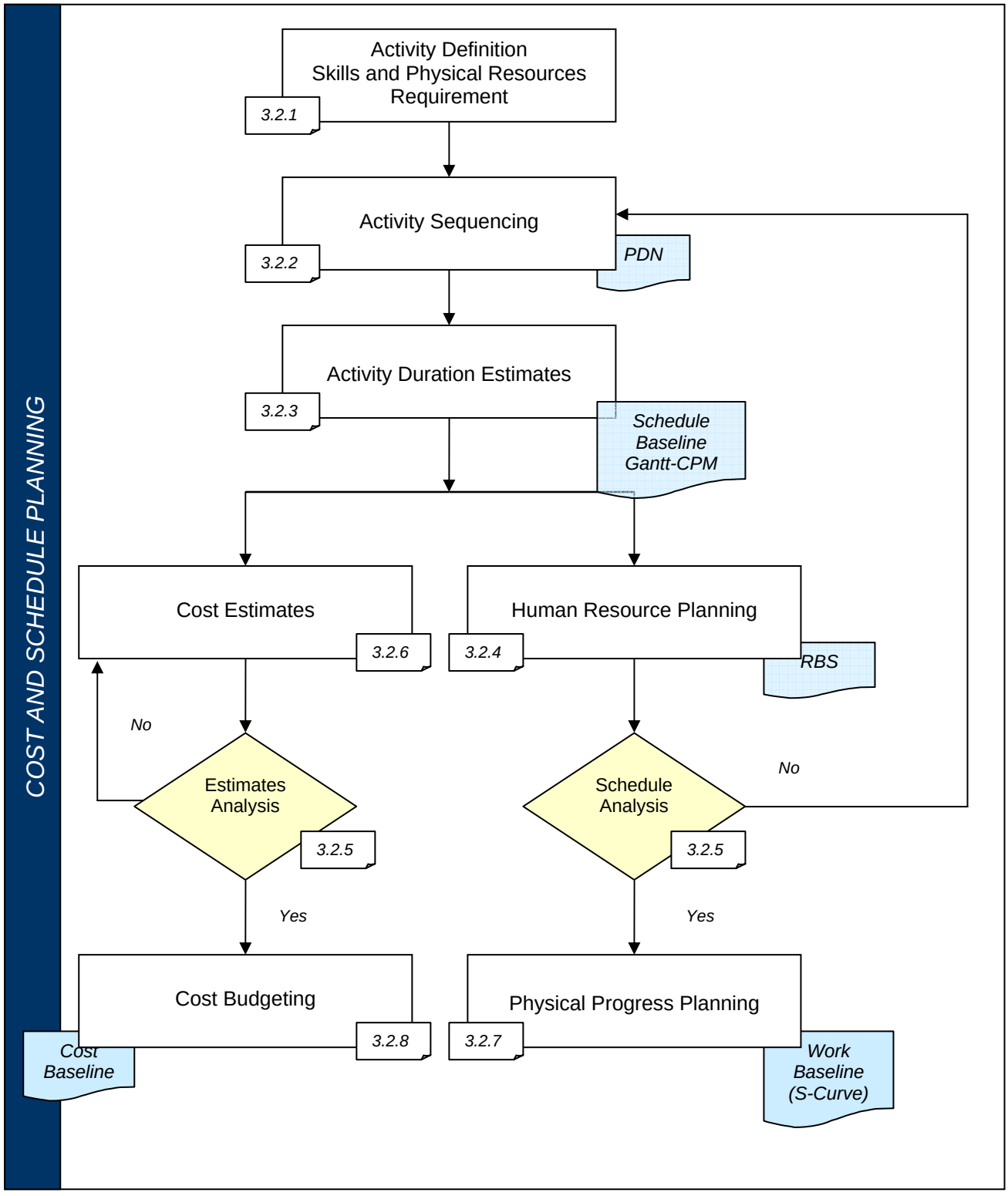
The organization breakdown structure is a hierarchical description of the project organization. It covers all those involved in the project, defining roles and responsibilities. Starting from the work breakdown structure, it specifically defines the member of the project team that will have the responsibility to plan or manage or control any group of related activities or work packages illustrated in the WBS and the related deliverables. The OBS also describes the different roles of team members and if necessary specifies what deliverables or work should be checked and managed by the entire team and who is responsible for controlling that the work done satisfies all the defined constraints and requirements. The OBS is usually less detailed than the WBS but it is developed starting from the WBS components and it generally has, almost in its higher levels, the same structure.

3.1.5.4 *Responsibility Assignment Matrix*

The responsibility assignment matrix is a matrix that relates tasks to people, correlating the work which must be done to project team members. The people can be shown as persons or groups. The matrix format clearly shows all activities associated with one person, or all people associated with one activity. For each task different skills can be involved: who is in charge to practically execute the task, who is responsible for it, who is consulted or just informed and who approves the task performed. The responsibility assignment matrix shows how every member of the project team should manage each major activity and what are the different roles covered by different members in the developing of the project. The matrix also illustrate how the team cooperate: who should be informed, who should execute, check, approve or collaborate in every project phase (see chapter 4 for further details).

3.2 Cost and schedule planning

This process identifies the specific activities that need to be performed to complete the various project deliverables. Analyzing activity sequences, durations, resource requirements, and schedule constrains this process creates project schedule and develops an approximation of the cost of the resources needed to complete each project activities and aggregates the estimated costs of work packages to establish a cost baseline.



3.2.1 Activity definition, physical resources and skills assignment

The activity definition identifies and documents the specific activities that need to be performed in order to produce the project deliverables. The process will identify the work packages as the deliverables at the lowest level in the work breakdown structure. Project work packages are decomposed into smaller, more manageable components called schedule activities that provide a basis for estimating, scheduling, executing, and monitoring and controlling the project work.
The activity definition is often performed by the project team members responsible for the work package. Each work package includes physical resources and skills assignment. Physical resources assignment includes a resources list that identify equipments and materials necessary and potentially available on the basis of historical information, marketplace condition and geographical or budget constraints and assumptions. Skills assignment determine project roles for the major work packages depending upon the required competences for managing each activity.

INPUT

3.2.1.1 *Work breakdown structure (WBS)* (see section *3.1.3.3*)
3.2.1.2 *Scope management plan* (see section *3.1.2.4*)
3.2.1.3 *Resource availability*
It determines kind and quantity of resources equipments or material available to perform project activities, depending upon project period, project expected duration, geographical and transportation constraints and other factors that could influence the resources accessibility.

OUTPUT

3.2.1.4 *Activity list and attributes*
The activity list includes all schedule activities planned to be performed on the project. The schedule activities are discrete components of the project schedule but they are not necessarily components of the WBS and they should be included in the schedule model as components of the project management plan. The activity list includes an activity identifier and a scope of work description for each schedule activity in sufficient detail to ensure that project team members understand what work is required to be completed.
The activity attributes are an extension of activities described in the activity list. For each activity schedule they specify a sufficiently detailed description that includes the predecessor and successor activities, the logical relationship, the expected leads or lags, the resource requirements, the imposed date and constraints. Activity attributes can also include the person responsible for executing the work, geographic area or place where the work has to be performed and other specific characteristics. The attributes are used for project schedule development and for selecting, ordering and sorting the planned schedule activities in various way within the reports.

3.2.1.5 *Physical resources list*
The physical resources list describes the type and quantity of material resources required for each schedule activity in a work package. It presents a tabulation of the physical assemblies, subassemblies, and components needed to fabricate a manufactured product. The level of detail of the physical resources can vary by application area. The list could also include a summary description of the quality requirements of the resources to be

applied and of the different kinds of constraint and assumption that could influence the procurement.

3.2.1.6 Skills assignment

It determines necessary capabilities for the major work packages depending upon the required competences for managing each activity. The skills assignment is developed with an understanding of the ways that existing organizations will be involved and how the technical disciplines and people interact with one another. The activity list and attributes as well as resource requirements, quality needs, risk management and work breakdown structure are primary issues to determine the required skills.

3.2.2 Activity sequencing

Activity sequencing involves identifying and documenting interactivity dependencies. Activities must be sequenced accurately in order to support later development of a realistic and achievable schedule in order to give a complete output. Schedule activities can be logically sequenced with proper precedence relationship using project management software or manual techniques. In order correctly sequence the activities, should be take into account:

- a summary milestone list where the most important deliverables are indicated;
- the required product characteristics that could affect activity sequencing, such as the physical layout of a plant to be constructed;
- the dependencies that need a lead that allows an acceleration or a lag that directs a delay of the successor activity; in this case the lead or lag application should be widely described because they could cause a review of the cost estimation and risk analysis.

The output of the step is a precedence network diagram that represents activities connected to each other to show relative dependencies. Four different types of relationship between activities could be included in such network:

- finish-to-start activities where the initiation of the successor activity depends upon the completion of the predecessor activity;
- finish-to-finish activities where the completion of the successor activity depends upon the completion of the predecessor activity;
- start-to-start activities where the initiation of the successor activity depends upon the initiation of the predecessor activity;
- start-to-finish activities where the completion of the successor activity depends upon the initiation of the predecessor activity.

The most common type of precedence relationship is a finish-to-start one, while the start-to-finish relationship is rarely used. There are three main kind of dependencies that influence and define the activity sequencing:

- mandatory dependencies inherent in the nature of the work being done that often involve physical limitation, such as on construction project where it is impossible to erect the superstructure until after the foundation has been built; mandatory dependencies are also referred as hard logic;
- discretionary dependencies determined by the project management team and based on knowledge of the best practices. Discretionary dependencies are fully documented since they can create arbitrary total float values and can limit later scheduling options; they are also referred to as preferred logic, preferential logic or soft logic;

- external dependencies caused by the relations between project and non-project activities; for example governmental environmental hearings may need to be held before site preparation can begin on a construction project.

INPUT

3.2.2.1 *Work breakdown structure* (see section *3.1.3.3*)
3.2.2.2 *Resource availability* (see section *3.2.1.3*)
3.2.2.3 *Activity list and attributes* (see section *3.2.1.4*)

OUTPUT

3.2.2.4 *Project schedule network diagram*
The project schedule network diagram is a precedence network diagram that illustrates the dependencies between the different activities, the project network logic and the activities expected dates. The network diagram uses boxes or rectangles, referred as nodes, to represent activities and connects them with arrows that show the dependencies. Some dependencies may require a lead that allows an acceleration of the successor activity (fast tracking) or a lag that directs a delay in the successor activity (used to check results or for risk management). A summary narrative accompanies the diagram and describes the basic approach used to sequence the activities. Some activities may have imposed dates or imposed relations with other activities and affect the develop of the precedence diagram network; such activities should be widely illustrated and continuously monitored.

3.2.3 Activity duration estimating

Activity duration estimating involves assessing the number of work periods likely to be needed to complete each identified activity. The person or group on the project team who is most familiar with the nature of a specific activity should make, or at least approve, the estimate. The activity duration estimating requires that the amount of work effort required, the assumed amount of resources to be applied, and the number of work periods needed to complete the schedule activity is determined. Estimating the number of work periods required to complete a schedule activity can require consideration of elapsed time as a requirement related to a specific type of work. It is necessary to handle this situation by using a project calendar and alternative work period research calendars that are usually identified by the resources that require specific work periods; the schedule activities will be worked according to the project calendar and the schedule activities to which the resources are assigned will also be worked according to the appropriate resource calendars. So the primary inputs to the duration estimating is the WBS with the related activity list and attributes, the resource availability and the calendar, as well as historical in formation on the likely duration of many categories of activity. Activity duration are often difficult to estimate because of the number of factors that can influence them, so an expert judgment, guided by historical information, can be used whenever possible and also the individual team members may provide duration estimate information or recommended maximum activity durations from prior similar projects.
The three mostly used techniques to perform a duration analysis are:
- analogous estimating: using the actual duration of the previous, similar schedule activity as the basis for estimating the duration of the future schedule activity is determined. This

technique is frequently used to estimate project duration where there is a limited amount of detailed information about the project, for example in the early project phases;
- parametric estimating: the basis for activity duration can be quantitatively determined by multiplying the quantity of work to be performed by the productivity rate; for example to determine activity duration in work periods the total resource quantities can be multiplied by the labor hours per work period or the production capability per work period, and divided by the number of those resources being applied;
- three point estimates are based on determining three types of estimates: most likely, optimistic and pessimistic. The most likely estimate gives the duration based on the resources likely to be assigned, the productivity, realistic expectation of availability for the schedule activity, dependencies on other participants , and interruptions. The optimistic and pessimistic estimation are based on the best-case and worst-case scenario. An activity duration estimate can be constructed by using an average of the three estimated durations, that average will often provide a more accurate activity duration estimate than the single point, most likely estimate.

The duration estimate is progressively elaborated, and the process considers the quality and availability of the input data.

INPUT

3.2.3.1 *Work breakdown structure* (see section *3.1.3.3*)
3.2.3.2 *Resource availability* (see section *3.2.1.3*)
3.2.3.3 *Activity list and attributes* (see section *3.2.1.4*)
3.2.3.4 *Calendar*

A calendar for the project documents working and non-working days that determine those dates on which a specific resource (person or material) can be active or idle. The project calendar also identifies the quantity of each resource available during each availability period.

OUTPUT

3.2.3.5 *Gantt*

Is a bar charts diagram, with bar representing activities, that shows activity start and end dates, as well as expected durations. It should be accompanied or include a milestone charts where the schedule start or completion of major deliverables and key external interfaces are identified. The Gantt chart is integrated by a narrative section where the expected activity and their durations are given with an indication of the range of the possible results, a time constraint where needed (such as imposed start or finish date) and a description of the possible leads and lags. The overall project duration is then determined from the logical relations and from the estimated durations of all the activities to be performed.

3.2.3.6 *Critical path activities*

The critical path activities are determined through a schedule network analysis technique performed using the schedule model (critical path method) . The critical path method calculates the theoretical early start and finish dates, and late start and finish dates for all schedule activities by performing a forward and backward pass analysis. Calculated early start and finish dates, and late start and finish dates, may or may not be the same on any group of time related activities. The total float (late start minus early start of every group of related activities) provides schedule flexibility and the critical path is defined as the group of activities with a zero total float, i.e. the group of activities that could not be delayed

without delaying all the project (critical activities). Once the total floats of the different paths are calculated, the free float, can be identified as the amount of time that a schedule activity can be delayed without delaying the start date of any other activity within the network path.

3.2.3.7 Schedule baseline

The schedule baseline includes at least planned start and finish dates for the overall project and for each schedule activity and it would remain preliminary until a resource assignment and the calendar have been confirmed. It should be approved by the project management team and it may be developed with defined target start date and target finish date for the milestones activities. It should also include a project schedule network diagram (see section *3.2.2.4*) with activity date information and critical path schedule activities (see section *3.2.3.6*) and a bar chart reporting milestones dates (see section *3.2.3.5* - Gantt)

3.2.4 Human resource planning

Human resource planning determines team members, roles and responsibilities for every scheduled activity, depending upon skills and quantity requirements. Using the work breakdown structure and the organizational breakdown structure as primary inputs the human resources are planned, and assigned to different work packages. The process defines how many people and what kind of competences should be used to perform project activities (procurement, engineering, reservoir, drilling). The team assignment should be made taking into account not only the required capabilities but also the constraints related to calendar and resource availabilities and the list of needed physical procurements.

INPUT

3.2.4.1 Schedule baseline(see section *3.2.3.7*)
3.2.4.2 Work breakdown structure (see section *3.1.3.3*)
3.2.4.3 Organization Breakdown Structure(see section *3.1.5.3*)
3.2.4.4 Calendar(see section *3.2.3.4*)
3.2.4.5 Resource availability(see section *3.2.1.3*)
3.2.4.6 Physical resources list(see section *3.2.1.5*)
3.2.4.7 Skills assignment(see section *3.2.1.6*)

OUTPUT

3.2.4.8 Resource breakdown structure (RBS)

The resource breakdown structure starts from the hierarchical decomposition of the work to be executed and determines roles, responsibilities, authority and reporting relationship for each work package. After initial team members identification (skills assignment – see section *3.2.1.6*), additional team members may need to be acquired. Project roles can be designed for persons or groups and should be developed with an understandings of the ways that existing organization will be involved and how the technical disciplines and people currently interact with one another. The RBS could be integrated with a staffing management plan that describes how and when project team members will be acquired and describes the training needs, the selection criteria and other considerations based on

the activity resource requirements, the working calendar and the project scope description.

3.2.5 Schedule and cost analysis

The project start and finish dates and the overall activity duration, as well as the estimated cost, should be compliant with the project objectives. The risk and issues management should be foreseen in order to prevent delays or extra costs in project closing. If the expected project duration is longer than it should be, a re-sequencing of the activities or a schedule compression should shorten the project schedule without changing the project scope especially in terms of quality and budget constraints. A schedule compression could be obtained by the fast tracking technique in which phases or activities that normally would be done in sequence are performed in parallel. Anyway fast tracking would probably require work to be performed without completed detailed information causing re-work, increased risks and probably increased costs. If the cost estimation (or the new estimation made after fast tracking) turn out to be higher than the planned one, a re-allocation of the resources should be made trying not to change the overall project duration and not to increase the risks. Risks and problems not correctly handled could cause a delay in project schedule; simulations and different scenarios analyses can help to prevent these schedule delay and resource reallocation from non-critical to critical activities is a common way to bring the project back on track, or as close as possible to its originally intended overall duration. In many cases a new schedule development will affect the scope of the project, causing problems in meeting the quality requirement and increasing project costs so schedule compression techniques (such as crashing techniques) analyze cost and schedule tradeoffs to determine how to obtain the greatest amount of time compression for the least incremental cost.

3.2.6 Cost estimating

A schedule activity cost estimate is a quantitative assessment of the likely cost of the resources required to complete the schedule activity. Estimating cost involves developing an approximation of the costs of the resources needed to complete each schedule activity; consider the possible causes of variation of the cost estimates including risks; identifying and considering various cost alternatives and analyze whether these alternatives could reduce the overall project estimation. Cost estimate can benefit from refinement during the course of the project to reflect the additional detail available: the accuracy of the project estimate will increase as the project progresses, for example a project in the initiation phase could have a rough order of magnitude estimate in the range of -50 to +100%; later in the project, as more information is known, estimate could narrow to a range of -10% to +15%. The costs for schedule activities are estimated for all resources that will be charged to the project; this include, but is not limited to, labor, materials, equipment, services, facilities, inflation allowance or a contingency cost. The main techniques to perform an estimation analysis are:

- analogous estimation: the estimator uses actual cost of previous, similar projects as the basis for the cost of current project. This technique is frequently used to estimate cost when there is a limited amount of detailed information about the project and is generally less costly and less accurate than other techniques;

- bottom-up estimating: this technique involves estimating the cost of individual work packages or individual schedule activities with the lowest level of detail. This detailed cost is then summarized to higher levels for reporting and tracking purpose. The cost and accuracy of bottom-up estimating is typically motivate by the size and complexity of the individual schedule activity or work package;
- parametric estimating: this a technique that uses a statistical relationship between historical data and other variables, such as square footage or required labor hours, to calculate a cost estimate for a schedule activity resource. It produces higher levels of accuracy depending upon the sophistication, as well as the underlying resource quantity and cost data built into the model.
- vendor bid analysis: this method include a vendor bid analysis and an analysis of what the project should cost, together with an additional estimation for the cost of the individual deliverables.

Besides the illustrated cost analysis, many estimator could include reserves, also called contingency allowances, as costs in many schedule activity cost estimates. Contingency reserves are estimated costs to be used at the discretion of the project manager to deal with anticipated but not certain events known as “known unknown”. The problem inherent with reserve analysis is to potentially overstating the estimated cost for the schedule activity.

INPUT

3.2.6.1 Commercial database and marketplace conditions

It regards information about what services or products are available in the marketplace, from whom and under what terms and conditions. It is mainly concerned with the cost of the resources needed to complete schedule activities and with identification and analysis of various costing alternatives.

3.2.6.2 Work breakdown structure (see section *3.1.3.3*)

3.2.6.3 Schedule baseline(see section *3.2.3.7*)

3.2.6.4 Cost management plan

The cost management plan establishes the criteria for planning, structuring, estimating, budgeting and controlling project costs such as:

- precision level: schedule activity cost estimate will adhere to a rounding of the data to a prescribed precision, based on the project complexity and magnitude and on the scope of the activities, and may include an amount for contingencies;
- units of measure such as staff hours, staff days, week, lump sum, etc, for each resources;
- control thresholds that are variance threshold for cost or other indicators at designed time points over the duration of the project defined to indicate the agreed amount of variation allowed;
- reporting formats and earned value analysis characteristics such as computation formulas for determining the estimate to complete, earned value criteria and level of the WBS at which earned value analysis technique will always be performed.

Additional details available during the course of the project are managed by the cost management plan in order to refine the cost expectations. The cost management plan is contained in, or is a subsidiary plan of, the project management plan and may be formal or informal, highly detailed or broadly framed, based upon the needs of the project.

OUTPUT

3.2.6.5 Activity cost estimates

An activity cost estimates is a quantitative assessment of the likely costs of the resources required to complete schedule activities. Costs are estimated for all resources applied to the activity, such as labor, materials, services, equipments, facilities and others. The estimate is also highly correlated with the schedule baseline and with the activity duration estimates that will affect cost estimates on any project. The development of the estimate should include a narrative section where a clear and complete picture of how cost estimate was carried out should be given, specifying the basis for the estimate, the assumption made, the constraints, the range of possible estimates and the possible causes of variation including risks.

3.2.7 Physical progress planning

Physical progress planning analyzes schedule and work breakdown structure in order to determine the expected process development in terms of work to be performed. The process identifies start and finish dates and should take into account the amount of assigned physical and human resources as well as project objectives. It is accepted and approved by the project team as the baseline against with monitor and control the development of the overall project. The output of the step is a work schedule baseline that illustrates all the activities to be performed with the specific start and finish dates and a cumulative "S" curve that shows the physical progress of the work to be done every time during the execution phase.

INPUT

3.2.7.1 Physical resources list(see section *3.2.1.5*)
3.2.7.2 Skills assignment (see section *3.2.1.6*)
3.2.7.3 Schedule Baseline(see section *3.2.3.7*)
3.2.7.4 Work breakdown structure(see section *3.1.3.3*)
3.2.7.5 Resource breakdown structure (see section *3.2.4.8*)

OUTPUT

3.2.7.6 Work schedule baseline

The work schedule baseline includes a detailed description of the work to be accomplished, the resources needed and the expected cost for each phase of the project. It is developed by analyzing different activities, activity durations, estimated costs and resource requirements by period and the information are usually integrated in a physical progress S-curve representing the work scheduled and the budgeted cost related. This S-curve is a basis against which to measure, monitor and control overall performance on the project. The developing of the work is usually measured through the earned value technique which compares the budgeted cost of the work scheduled (BCWS or planned value-PV) with the budgeted cost for the work actually performed (BCWP or earned value-EV) and with the actual cost incurred in accomplishing work performed (ACWP or actual cost-AC); the obtained results are used to define the cost variance (CV=EV-AC) and the schedule variance (SV=EV-PV) in order to determine the cost and time performances and to give an estimate at completion for the overall project.

3.2.8 Cost budgeting

Cost budgeting involves phasing the estimated costs of individual schedule activities or work packages to establish a total cost plan for measuring project performance. A summary budget is provided by the project scope description, however schedule activity or work packages cost estimates are prepared prior to the detailed budget request and work authorization. Activity cost estimates may be aggregated by work packages in accordance with the WBS, described for higher components levels and then for the entire project. The budget analysis also analyze the need for a contingency reserve for the overall project (different from the ones estimated for every activity in section 3.2.6-cost estimating), this reserve is for unplanned changes to project scope and cost, known as “unknown unknown” events. The budget analysis could also be performed using a sort of parametric estimation that analyze the project characteristics in a mathematical model to predict project total cost. The accuracy and cost of parametric models vary widely with historical information and reliability of quantified parameters. Cost budgeting recognizes the importance of proper budget estimation, matches the inputs of the process to the role they play in creating cost baseline and develops a cumulative cost curve depending on overall budget and project schedule.

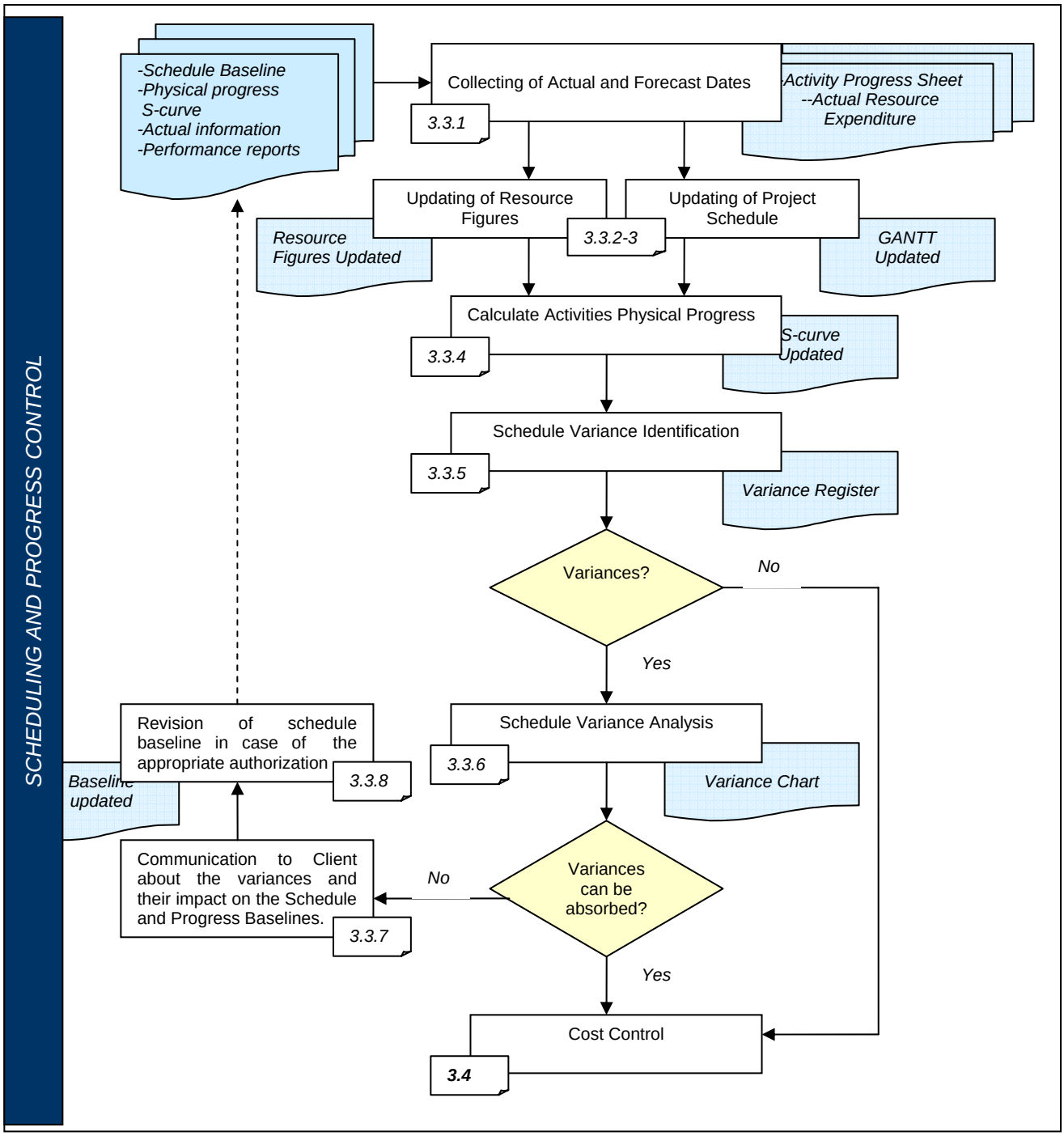
INPUT

3.2.8.1 *Work breakdown structure*(see section *3.1.3.3*)
3.2.8.2 *Activity cost estimates*(see section *3.2.6.5*)
3.2.8.3 *Schedule baseline* (see section *3.2.3.7*)
3.2.8.4 *Cost management plan* (see section *3.2.6.4*)
3.2.8.5 *Resource Availability* (see section *3.2.1.3*)
3.2.8.6 *Physical resources list* (see section *3.2.1.5*)
3.2.8.7 *Skills assignment* (see section *3.2.1.6*)

OUTPUT

3.2.8.8 *Cost baseline*
The cost baseline is a time-phased budget that is used as a basis against which to measure, monitor and control the overall cost performance on the project. It is developed by summing estimated costs by period and is usually displayed in the form of an “S” curve. Many projects, especially large ones, have multiple cost or resource baselines, and consumables production baselines, such as cubic meters of concrete per days, to measure different aspects of project performance. Even the funding requirements, total and periodic, are derived from the cost baseline.

3.3 SCHEDULING AND PROGRESS CONTROL



The Scheduling and Progress monitoring is carried out after the Planning and Scheduling, Cost Estimation and Cost Budgeting Processes and, using their final outputs as primary inputs, it aims at:

- scheduling monitoring (Project duration control),
- progress monitoring (evaluation of the project physical progress) and
- resource monitoring (evaluation of actual resources' expenditure and resources to complete).

The Scheduling and Progress monitoring is used to make a forecast of remaining work to complete and to determine if work progress is in accordance with the plan and schedule. Thus the purpose of scheduling and progress control is to guarantee that the project will be complete on time and the objectives defined with Planning and Scheduling Process are

fully achieved. The output of Scheduling and Progress control activities serve as an input for further Cost control.

3.3.1 Collecting of actual and forecast dates

Collecting of actual and forecast dates is needed to establish the up to date situation and to compare it versus a baseline. The required information, collected by the Project Team, should be provided by the responsible of each activity. The gathered information should contain the following data: schedule dates, progress dates and resource dates which means:
- activities actual start and finish dates;
- activities forecast start and finish dates;
- activities remaining duration;
- actual resource's expenditure for each activity;
- resource estimate to complete each activity;

This required information must be consistent with the planning and scheduling breakdowns in order to guarantee the coherence of actual vs. planned figures comparison. Most of the activities are usually carried out by third parties, so it is necessary that the information generated by these entities are properly assessed, collected and provided to project team.

INPUT

3.3.1.1 *Schedule baseline* (see section *3.2.3.7*)

3.3.1.2 *Progress dates (Performance report)*
The performance report is a formal or informal document that describes the information on actual dates received both from project team members and from external organization that are carrying out part of the work.

3.3.1.3 *Resource breakdown structure* (see section *3.2.4.8*)

OUTPUT

3.3.1.4 *Activity Progress Sheet*
The activity report sheet is a document that shows actual and forecast dates and illustrate how the analysis between actual and planned dates has been carried out, in order to give a detailed description of how forecast dates have been obtained. It analyzes all the activities performed and to be performed comparing them with the schedule baseline.

3.3.2 Updating of project schedule

In order to realize the scheduling monitoring of the project execution the collected information, relative to the scheduling actual dates, should be compared with the baseline of the project. The information collected in the previous step are analyzed and the dates and work performed are compared with the expected ones, that have been planned and documented in the schedule and work schedule baselines. In particular for each activity there will be a comparison among the dates listed in the following scheme:

- completed activities: the actual start and finish dates of the activities already completed will be compared with the expected dates and the difference will be analyzed in order to make a forecast for the activities to be completed or not already started;
- activity in progress: the start date of the activity is compared to the planned start date and a finish date is forecast and compared to the planned one, the related activities will be analyzed depending on difference between actual and planned results;
- activity not started: the forecast start and finish dates of these activities are calculated from the analyses of the activities already finished or in progress; then the forecast dates are compared with the schedule baseline.

INPUT

3.3.2.1 *Schedule baseline* (see section *3.2.3.7*)
3.3.2.2 *Work schedule baseline* (see section *3.2.7.6*)
3.3.2.3 *Cost baseline* (see section *3.2.8.8)*
3.3.2.4 *Activity progress sheet*(see section *3.3.1.4*)

OUTPUT

3.3.2.5 *Gantt updated* (see section *3.2.3.5*)

3.3.3 Updating of resource figures

In order to realize the resource monitoring of the project execution the collected information, relative to the actual resource's expenditure, should be compared with the baseline of the project. Resource monitoring is aimed at:
- quantifying the resource expenditure for execution of project activities;
- quantifying resource requirements for project activities to be completed;
- update resources estimates on the basis of previous resource expenditure and resource requirements for project activities to be completed.

Resource monitoring is applicable to all types of resource and all project activities. Actual and forecast resource figures should be analyzed on an integrated basis with the work schedule baseline and the physical progress "S" curve in order to deduce the effective resource performance. The most used performance index (RPI-resource performance index) calculate the ratio between earned resource (physical progress (%) * resource budget) and actual used resource.

INPUT

3.3.3.1 *Schedule baseline* (see section *3.2.3.7*)
3.3.3.2 *Work schedule baseline* (see section *3.2.7.6*)
3.3.3.3 *Cost baseline* (see section *3.2.8.8)*
3.3.3.4 *Activity progress sheet*(see section *3.3.1.4*)

3.3.3.5 *Actual resource expenditure*
The information on resource expenditure of each performed or in progress schedule activity are collected and quantified for all resources that will be charged to the project in

order to perform an efficiency analysis on the basis of actual work performed and planned work.

OUTPUT

3.3.3.6 Resource figures updated

The updated resources assigned to every work packages or activity to be performed or in progress are documented and illustrated in a formal or informal way, in order to correctly inform every project team member on the developing of the project.

3.3.4 Calculate project physical progress

The physical progress calculation should be based on the evaluation of the work actually performed, in terms of deliverables, measurable outputs or achieved events. This process should be carried out according to the following steps:

- assess the work actually performed for each activity of the Project GANTT (updated);
- calculate the actual physical progress applying to the work actually performed the progress calculation criteria adopted for the specific activity.

The criteria to be adopted are:

- 0-100 (ON/OFF): This criteria is applied to activities which start and hopefully complete within a control interval. No progress is assigned when the activity starts, but 100 percent is assigned when completed.
- 50-50: With this criteria 50 percent of progress is assigned when the activity starts, and the balance is assigned when the activity is completed.
- Actual quantity: This criteria consists in determining the progress by comparing the quantity of work actually performed at the given moment against the total quantity of work to be performed in order to complete the activity.
- Milestone: This approach consists in the assessment of activity progress according to the achievement of a certain number of intermediate weighted events. Each of these events should be weighted with respect to the activity 100 percent. When the events are actually achieved, then the sum of their relevant weight is assumed to be the activity actual progress.
- Progress estimate: This approach produces an estimate of the percentage of work completed, usually cumulative, to be made in a given moment of time by the responsible of the activity.
- Apportioned effort: This criteria applies to those activities which have a direct performance relationship with some other activities called their reference base. According to this criteria the activity progress is assumed to be equal to the overall project progress.
- LOE (Level of effort): This criteria is used to those activities which are necessary to a project but are more time oriented then task/output related. For these activities the actual progress is assumed to be equal to the planned figures.

The actual progress figures calculated for each activity according the criteria indicated above should be used for the update of the physical progress “S” curve. The updating process consists in the weighted aggregation of the progress figures calculated for each activity, in order to build the Actual physical progress “S” curve.

INPUT

3.3.4.1 *Schedule baseline* (see section *3.2.3.7*)
3.3.4.2 *Work schedule baseline* (see section *3.2.7.6*)
3.3.4.3 *Activity progress sheet*(see section *3.3.1.4*)
3.3.4.4 *Resource figures updated*(see section *3.3.3.6*)

OUTPUT

3.3.4.5 *Cost baseline updated* (see section *3.2.3.7*)
3.3.4.6 *Activity progress sheet updated* (see section *3.2.7.6*)

3.3.5 Schedule variance identification

In order to identify all deviation and variance that should be done, the actual schedule and physical progress "S" curve should be compared with the corresponding planned figures. When a milestone is reached or at regular intervals, the actual schedule figures and physical progress data should be compared with the corresponding planned figures and the variance between the two analyzed. The variance identification process consist of a screening aimed at highlighting only those variances which are of significant entity and which must be analyzed and dealt with in order to ensure that established project schedule and progress objectives can continue to be met.

INPUT

3.3.5.1 *Schedule baseline updated* (see section *3.2.3.7*)
3.3.5.2 *Work schedule baseline updated* (see section *3.2.7.6*)

OUTPUT

3.3.5.3 *Variance register*
The variance register is a document where all variance identified are reported and illustrated in order to be analyzed and evaluated. The register is necessary for monitoring the project development, analyzing the risks associated with the variances accepted, understanding the reasons for those variances and maintaining an useful documentation for future projects.

3.3.6 Schedule variance analysis

The variance analysis use the variance register as primary input and is aimed at:
- determining the causes of variances;
- evaluating the impact on project objectives;
- identifying possible corrective actions;
- evaluating the impact of these corrective actions on project schedule baseline.

Causes of variances include, but are not limited to, :
- change in planning base parameters
- incorrect evaluations during the planning phase
- unpredicted accidents and circumstances

- materials or services supply problems
- market problems
- inefficient or inadequate working methods
- changes occurred during execution of work.

The main aspect of the variance analysis consists in an estimation of the general impact of variations on the project as a whole. Particular attention should be paid to the delays to the project.

INPUT

3.3.6.1 *Variance register*(see section *3.3.5.4)*

OUTPUT

3.3.6.2 *Variance chart*

The variance chart is a document where, after all variances identified in the variance register have been analyzed and evaluated, the results obtained from these analyses are described. The variance charts shows, if a variance should be undertaken or not, what project parameters would be affected in terms of risks, costs and schedule development. The analysis of the consequences of any variance gives an indication about its impact about the possibility to absorb it into the project recognized boundaries.

3.3.7 Schedule variance absorption

Once the variance analyses have been carried out and one or more possible corrective actions have been identified, the project team should verify if these actions absorb the variances. There are two possible scenarios:

- total absorption;
- partial absorption.

In total absorption results from the verification, the scheduling and progress control process ends with the implementation of the appropriate corrective actions. In case of partial absorption (or no absorption), the project team should produce a document for the client highlighting the causes of the variance and their impact on the schedule and progress baselines. Wherever the client considers it necessary, it may authorizes a revision of schedule and progress baselines.

INPUT

3.3.7.1 *Schedule baseline updated* (see section *3.2.3.7*)
3.3.7.2 *Work schedule baseline updated* (see section *3.2.7.6*)
3.3.7.3 *Variance chart*(see section *3.3.6.2)*

OUTPUT

3.3.7.4 *Report concerning the variances and their impact.*

3.3.8 Revision of schedule baseline

The revision of schedule and progress baselines is a process that leads to the modification of initial baseline due to the fact that it no longer constitutes a valid reference point for cost monitoring purposes. Such a process essentially takes place when variations in the scope of work occur or when baselines are no longer coherent with the actual schedule and progress situation. The revision of the schedule and progress baseline should take place only when the client changes the scope of the work or if variance between forecast dates and physical progress "S" curves have been recognized as necessary to reach the required deliverables. Anyway, the revision of the baseline should be approved by project top management and usually by the client because it could lead to a delay or increased risk and cost of the overall project.

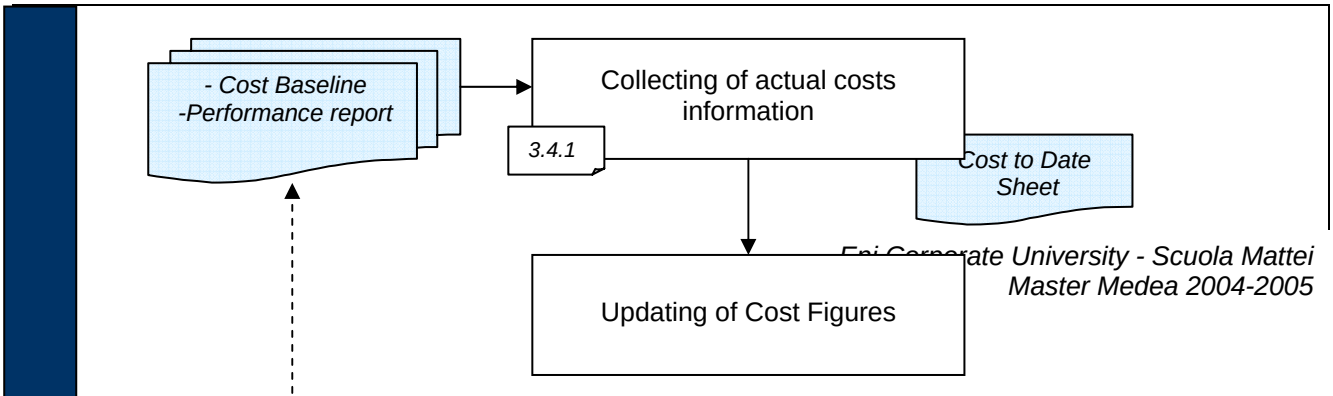
INPUT

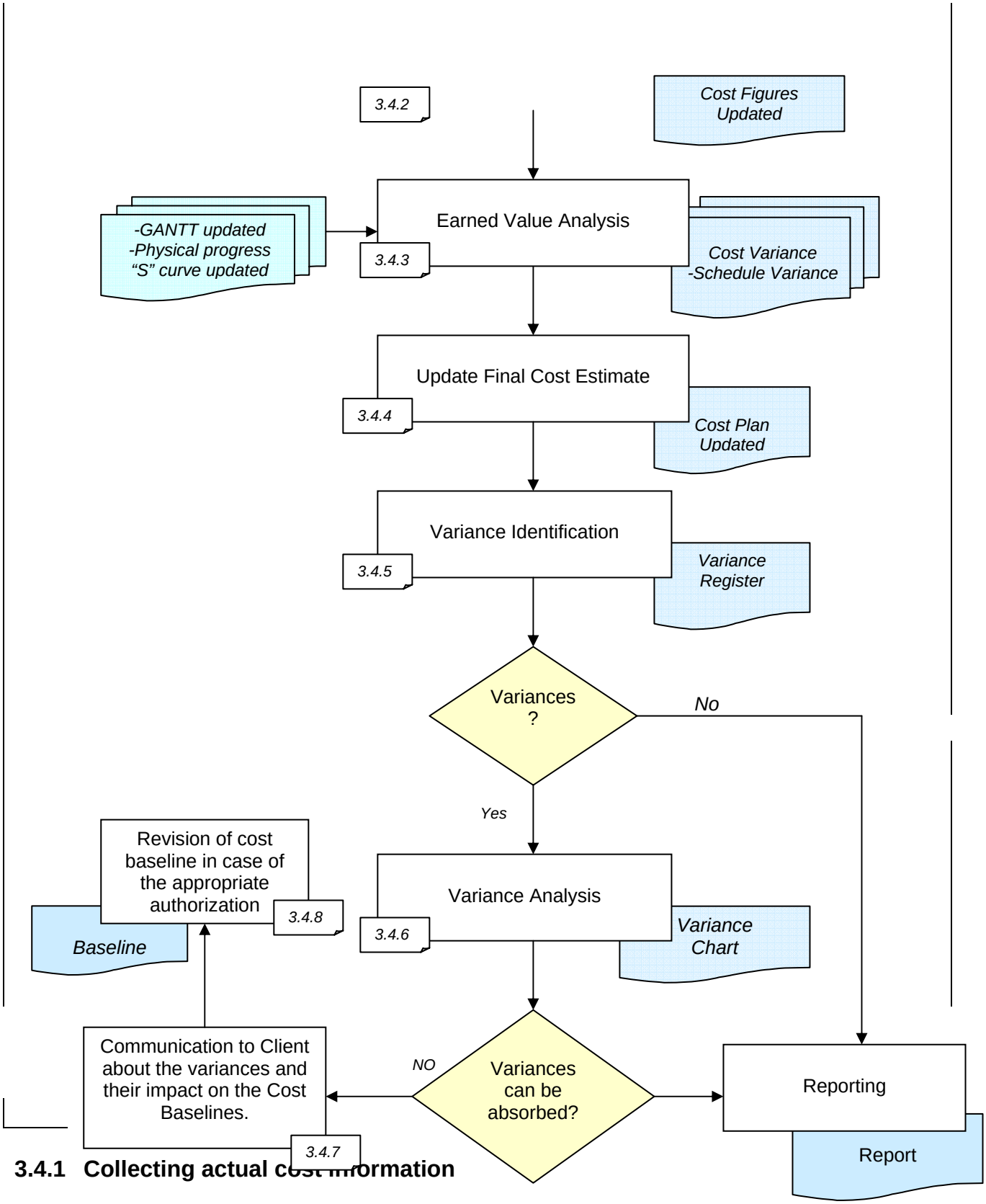
3.3.8.1 *Schedule baseline updated* (see section *3.2.3.7*)
3.3.8.2 *Work schedule baseline updated* (see section *3.2.7.6*)
3.3.8.3 *Report concerning the variances and their impact* (see section *3.3.7.5)*

OUTPUT

3.3.8.4 *Schedule baseline updated* (see section *3.2.3.7*)

3.4 COST CONTROL





3.4.1 Collecting actual cost information

This process includes all the activities related to the collection of the actual costs information required for the cost control purposes and should be carried out by the project team, gathering the actual data from various sources such as:

- accounting;
- procurement;

- suppliers and contractors progress measurement.

INPUT

3.4.1.1 Performance reports

The performance reports are formal or informal documents illustrating the actual work performed and, for activity still in progress, the work to be done in the new few months. These documents could be provided by the internal team or either by external organizations such as contractors or services supplier and they must be detailed in such a manner that the committed, accounted, invoiced and actual costs are easily understandable.

OUTPUT

3.4.1.2 Project cost data

Through the collection of the performance reports coming from different internal or external organization involved in the project, the data on actual cost sustained are collected and organized in order to be accessible to project team members and updated.

3.4.2 Updating cost figures

The cost figures to be adopted are mainly collected from the project cost data or directly from the performance reports and are divided in four different categories: committed costs, accounted costs, actual costs and invoiced costs.

The committed costs figures include the value of all financial undertakings made, through the issue of material purchase orders or contracts. The value should include orders issued within open contracts. For the lump-sum contracts the total cost is to be considered committed, while for the open contracts the committed value is calculated as the sum of the job orders issued in the domain of that specific contract at the actual date. Since the committed figures do not represent a real actual cost, they should be carefully analyzed in order to evaluate their trend as a primary source for the estimate of costs to complete, and for this reason it is essential to determine the to-be committed value which the sum of the orders and contracts still to be awarded.

The accounted costs figures include the sum of the cost already registered in the accounting system. As far as these figures are entered in a legacy system their accuracy is 100%. Accounted costs are the basis for the assessment of the actual costs.

The invoiced cost figures are the costs already certified and registered. They refer to activities or work packages finished in the previous phase of the project and they are collected with a 100% accuracy.

The actual cost figures (ACWP = actual cost of work performed) should be addressed by the project team by integrating the accounted costs with an actual estimated value of the work done determined on the basis of the following elements:

- internal cost related to:
  - resources expenditure
  - mission and traveling expenditure
  - other internal costs;
- external cost related to:
  - approved progress tickets related to job orders issued within open contracts
  - approved progress for contracts

- material supply progress evaluated according to achieved supply milestones.

The actual cost value is not 100% accurate but it should represents the best picture of project actual costs and guarantees the consistency between the cost and progress figures, representing so the base for carrying out earned value analyses and estimates of cost to complete.

INPUT

3.4.2.1 *Cost baseline* (see section *3.2.8.8)*
3.4.2.2 *Project cost data* (see section *3.4.1.2)*

OUTPUT

3.4.2.3 *Cost estimate to complete (ETC)*

The estimate to complete (ETC) start from the actual cost figures and is the best possible estimate of further expenditure necessary for the completion of each project activity. In order to determinate the ETC value the following aspects should be considered and evaluated for each cost element:
- actual cost;
- cost trends and cost performance;
- estimate of resource requirements to complete;
- market information on prices of material and services to be purchased;
- potential variations due to project planning modification.

The ETC value can be determined according to several estimating criteria depending on the nature of the cost which they refer to:
- input: estimated manually;
- constant budget: implies that the actual costs evolve according to the original budget and that the same budget can be confirmed. So the estimate to complete is: ETC = BAC (original budget) – ACWP (actual cost work performed);
- constant estimated final cost (EFC): implies that the actual costs evolve according to the estimated final cost and that the same estimate can be confirmed. So the estimate to complete is: ETC = EFC (estimated final cost) – ACWP (actual cost work performed);
- to be committed: the ETC is assumed to be equal to the to-be committed costs;
- projected: allow the calculation of the ETC using the earned value analysis (see section 3.4.3).

3.4.2.4 *Cost estimation updated*(see section *3.2.6.5)*

3.4.3 Earned value analysis

Earned value analysis is a methodology which enables the proper evaluation of cost trends in order to support the estimation of costs to complete integrating the actual cost data with the work actually performed. The earned value analysis is based on the following parameters:
- BAC: budget at completion, which is the original budget;
- BCWS: budgeted cost for work scheduled, which is the value of work that should have been done at a given point in time. It indicates the budget and work targets at a given point (planned value);

- BCWP: budgeted cost for work performed, which is the value of work actually done at a given point in time. It takes the work that has been done and the budget for each task and indicates what portion of the budget should have been spent to achieve it (earned value);
- ACWP: actual cost for work performed, which is the actual cost of the work done and it may vary from that budgeted. ACWP is the amount reported as actually expended in completing the work accomplished within a given time period (actual value).

The earned value analysis is carried out through the following steps:
- BCWP calculation: BCWP = Physical progress(%) * BAC;
- cost variance calculation: cost variance = BCWP – ACWP;
- schedule variance calculation: schedule variance = BCWP – BCWS;
- cost performance index (cpi) calculation: cpi = BCWP/ACWP;
- ETC calculation: ETC = (BAC – BCWP)/cpi;
- EFC calculation : EFC = ACWP + ETC.

The ETC calculation is based on the assumption that past cost performance will be maintained also for the future. The EFC constitutes a trend-based modification of the original budget and it's a forecast of most likely project cost based on the past project performance. The EFC should be compared to the original budget for the calculation of the expected final cost variance, which represents the final potential cost deviation. The prompt identification of a potential variance is required to initiate a process of analysis, evaluation of its impacts on project budget and corrective actions that may be taken to adsorb its effects. In order to be able to determine the project cost trend, it's essential to carry out a comparison between current and previous EFC to establish whether the gap between original budget and estimated final cost is increasing or shrinking and also to evaluate the effectiveness of the corrective actions undertaken.

INPUT

3.4.3.1 *GANTT updated* (see section *3.2.3.5*)
3.4.3.2 *Cost figures updated* (see section 3.4.2)

OUTPUT

3.4.3.3 *Cost estimate to complete (ETC) through the projected method*
3.4.3.4 *Estimated final cost (EFC)* (see section 3.4.3)

3.4.4 Update final cost estimate

After ETC and EFC determination during the earned value analysis, the cost plan should be updated in order to take into account the results found and the current cost and schedule projections. The update of the cost plan basically consist in updating the cost baseline, i.e. the cost "S" curve, and the work schedule baseline, i.e. the physical progress "S" curve.

INPUT

3.4.4.1 *Cost baseline* (see section *3.2.8.8)*
3.4.4.2 *Cost estimate to complete (ETC)* (see section *3.4.3.8*)
3.4.4.3 *Estimated final cost (EFC)* (see section 3.4.3)

OUTPUT

3.4.4.4 *Budget updated* (see section *3.2.8.8*)

3.4.5 Cost variance identification

In order to identify all deviation and variance that should be done, the actual cost plan and cost "S" curve should be compared with the corresponding planned figures. When a milestone is reached or at regular intervals, the actual budget figures should be compared with the corresponding planned figures and the variance between the two analyzed. The variance identification process consist of a screening aimed at highlighting only those variances which are of significant entity and which must be analyzed and dealt with in order to ensure that established project schedule and progress objectives can continue to be met.

INPUT

3.4.5.1 *Cost estimate to complete (ETC)* (see section *3.4.3.8*)
3.4.5.2 *Estimated final cost (EFC)* (see section 3.4.3)

OUTPUT

3.4.5.3 *Variance register*

3.4.6 Cost variance analysis

The variance analysis use the variance register as primary input and is aimed at:
- determining the causes of variances;
- evaluating the impact on project objectives;
- identifying possible corrective actions;
- evaluating the impact of these corrective actions on project cost baseline.

Causes of variances include, but are not limited to, :
- change in planning base parameters
- incorrect evaluations during the planning phase
- unpredicted accidents and circumstances
- materials or services supply problems
- market problems
- inefficient or inadequate working methods
- changes occurred during execution of work.

The main aspect of the variance analysis consists in an estimation of the general impact of variations on the project as a whole. Particular attention should be paid to the delays to variance in total cost.

INPUT

3.4.6.1 Variance register(see section 3.3.5.4)

OUTPUT

3.4.6.2 Variance chart(see section 3.3.6.2)

3.4.7 Cost variance absorption

Once the variance analyses have been carried out and one or more possible corrective actions have been identified, the project team should verify if these actions absorb the variances. There are two possible scenarios:
- total absorption;
- partial absorption.

In total absorption results from the verification, the cost control process ends with the implementation of the appropriate corrective actions. In case of partial absorption (or no absorption), the project team should produce a document for the client highlighting the causes of the variance and their impact on the cost baseline. Wherever the client considers it necessary, it may authorizes a revision of cost baseline and budget.

INPUT

3.4.7.1 Variance chart(see section 3.3.6.2)

OUTPUT

3.4.7.2 Report concerning the variances and their impact

3.4.8 Revision of cost baseline

The revision of cost baselines is a process that leads to the modification of initial baseline due to the fact that it no longer constitutes a valid reference point for cost monitoring purposes. In other words, the revision of cost baselines should only take place when baselines are no longer coherent with the actual cost situation and are thus no longer achievable. The revision of the cost baseline should take place only when the client changes the scope of the work or if not-absorbable variance between the estimated final cost and the original budget have been recognized. Anyway, the revision of the baseline should be approved by project top management and usually by the client because it could lead to a delay or increased risk and cost of the overall project. The revision of cost baseline shall start with the revision of the original budget consisting in the calculation of a revised budget, which becomes the new cost objective within which the project must be

completed. The revised budget is normally assumed to be equal to the estimated final cost. The revised cost baseline will be represented as an “S” curve showing the distribution of the revised budget on a time phased base; the “S” curve will result from the integration of two parts:
- the actual cost from the project start to now
- the estimate to complete from now to the project finish date.

INPUT

3.4.8.1 *Report concerning the variances and their impact*
3.4.8.2 *Estimated final cost (EFC)* (see section 3.4.3)
3.4.8.3 *Cost estimate to complete (ETC)* (see section *3.4.3.8*)

OUTPUT

3.4.8.4 *Cost baseline update*

CHAPTER 4

THE RESPONSABILITY ASSIGNMENT MATRIX

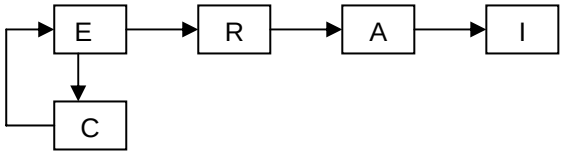
4 RESPONSABILITY ASSIGNMENT MATRIX

As already described in this work, a responsibility assignment matrix (RAM) is a tool to illustrate the connections between work to be done and project team members responsible for it. A RAM can be developed at various levels, according to projects needs and characteristics. In this work, the whole flow chart has been divided into its main parts: project definition, budget and schedule planning, schedule and progress control, cost control. For each of these four parts, it has been created a responsibility assignment matrix where it is defined the role of each person for each work package.
The roles which have been identified are:

- approve: the act of formally confirming, sanctioning, ratifying, or agreeing to something
- comment: who comments has the in charge of consulting, giving advice to who actually does an activity. He should contribute with his experience and provide further information and understanding of the task.
- execute: executing means directing, managing, performing, and accomplishing the project work, providing the deliverables, and providing information about work performed.
- informed: who is not directly involved in an activity is just informed about the relevant issues concerning that activity. According to the situation, information can be more or less detailed, provided regularly or only in particular moments, with a formal document or in an informal way.
- responsible: is the role of who is responsible for the work performed by the executor. He will need to control and pilot the performance of the executer, to ensure that the deliverable can be consequently approved.

The logical path which is to be followed for each work package of the WBS can be represented as follows:

A*= Approval* ***C****= Comment* ***E****=Execute* ***I****=Informed* ***R****=Responsible*



The executer actually does the work package, with the support and assistance of the one who comments. Who comments can influence the result of the deliverable, providing its opinion and consulting, but doesn't materially do the activity. Another person is responsible for the work performed and is the reference point for any sudden problem or controversy. If the responsible is satisfied by the work performed by the executer, then the deliverable is passed to who should approve it. At the end of this process, all those called "informed" receive a more or less formal report on the activity.

For each step of the workflows identified in chapter three, a responsibility assignment matrix is defined, taking the following project organization roles as reference:

- the develop manager
- the discipline manager
- the project service manager

- the cost estimator
- the planner
- the cost controller.

4.1 Project Definition

	Activity Description	Development Manager	Discipline Manager	Project Service Manager	Cost Estimator	Planner	Cost Controller	Deliverables
PROJECT DEFINITION	General Scope Definition	A	C	R/E	I	C	I	Project Charter
	Product and Project Scope	A	C	R/E	C	C	I	PBS Scope Management Plan
	Project Detailed Description	A	C	R/E	C	C	I	WBS
	WBS Analysis	A	C	R/E	I	I	I	
	Responsibilities Assignment	R/A	C	E	I	I	I	OBS RAM

4.2 Cost and Schedule Planning

	Activity Description	Development Manager	Discipline Manager	Project Service Manager	Cost Estimator	Planner	Cost Controller	Deliverables
ACTIVITY PLANNING	Activity List Physical Resources	A	C	R	I	E	I	
	Activity Sequencing	A	C	R	I	E	I	PDN
	Activity Duration Estimates	A	C	R	C	E	I	Schedule Gantt-CPM
COST PLANNING	Cost Estimates	C	C	R	E	C	I	
	Estimates Analysis	A	I	R	E	I	I	
	Cost Budgeting	A	C	R	E	C	I	Cost baseline
SCHEDULE PLANNING	Resource Planning	A	C	R	C	E	I	RBS
	Schedule Analysis	A	C	R	I	E	I	
	Physical Progress	A	I	R	I	E	I	Work Schedule Baseline

4.3 Schedule and Progress Control

	Activity Description	Development Manager	Discipline Manager	Project Service Manager	Cost Estimator	Planner	Cost Controller	Deliverables
SCHEDULE & PROGRESS CONTROL	Collecting of Actual and Forecast Dates	A	C	R	I	E	I	
	Updating of Resource Figures	A	E	R	I	C	I	
	Updating of Project Schedule	A	C	R	I	E	I	Updated Gantt
	Calculate Activities Physical Progress	A	C	R	I	E	I	Updated S-Curve
	Variance Identification	A	I	R	I	E	I	Variance Register
	Variances?	A	C	R	I	E	I	
	Variance Analysis	A	C	R	I	E	I	Variance Chart
	Variances can be absorbed?	A	C	R	I	E	I	
	Revision of Schedule Baseline	A	C	R	C	E	I	

4.4 Cost Control

	Activity Description	Development Manager	Discipline Manager	Project Service Manager	Cost Estimator	Planner	Cost Controller	Deliverables
COST CONTROL	Collecting of Actual Costs Information	A	C	R	C	C	E	
	Updating Of Cost Figures	A	I	R	E	I	I	
	Earned Value Analysis	A	C	R	E	E	C	
	Update Final Cost Estimate	A	I	R	E	I	C	
	Variance Identification	A	C	R	I	E	I	Variance Chart
	Vaiances?	A	C	R	I	E	I	
	Variance Analysis	A	C	R	E	I	C	Variance Chart
	Variances can be absorbed?	A	C	R	E	I	C	
	Reporting	A	C	R	E	I	I	Report
	Revision of Cost Baseline	A	C	R	E	I	C	