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ICT Project Management Methodology

Marta Fernández-Diego and José-Onofre Montesa-Andrés

An Information and Communications Technology (ICT) project manager must have a clear idea of his work, the frontiers of his working area, and any "de jure" and "de facto" criteria that may be useful. This paper describes a chronological project life method using the PMBoK model, which is widely used in many sectors and adopted by the IEEE as standard 1490 for ICT Project Management. The PMBoK Guide is organized into five chronological stages and resembles the post-contractual stages of the better known cycles, models, and methods used in ICT Project Management.

Keywords: ICT, Management, Methods, Projects.

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1 Definitions and Standards

A project, or "a temporary effort to create a result"[1] *, in this case an* Information and Communications System *(ICS), combines a set of documents for communication between the agents involved with a communications package related with the computing hardware. The proportion of both types of communication is variable, just one package of software for simple and obvious solutions, or just a set of documents, for example, in a consultancy project.*

It may be useful if the project structure follows the development life-cycle underlying the project manager's activities execution methods for those activities prior to the contract and for those activities needed in order to fulfil the contract. So a project manager could follow a chronological life-cycle complementing the result construction stage cycle undertaken by the managed team, without confusing the two.

The Project Management Institute (PMI) systematically publishes and updates the Project Management Body of Knowledge guide (PMBoK Guide)[1], a project management method for all types of sectors and services, starting from a contractual agreement reached between the client and supplier[2] . PMBoK is universally known and followed, and as such, it is a *de facto* standard, partially supported by *de jure* national and international standards[3] .

In the ICS specific sector, the IEEE Computer Society[4] has also adopted the PMBoK Guide, and has published *de facto* standard IEEE 1490-2003 which is commonly accepted as the knowledge and practice usually applicable to most projects.

Standard 1490 can be used separately, or jointly, with seven other IEEE standards: 12207 for life-cycle; 610.12 for terminology; 1028 for revisions; 1044 for anomaly classification; 1045 for productivity metrics; 1058 for project management plans; and 1074 for development processes. IEEE 1490 also analyses the correlation in key terminology between the PMBoK Guide and IEEE software engineering standards, and accordingly:

- IEEE 1490 takes from the PMBoK Guide the definition of **project life-cycle** as "*a set of generally sequential stages whose name and number determine the control needs of the organizations involved*", and from standard IEEE 610.12 the definition of **software life-cycle** as "*the period starting when a software project is conceived and ending when the software is unavailable for use*". Although both definitions have a temporal dimension, the PMI definition is limited to a specific project and is centred on its control; while the IEEE definition includes the whole of the life of the software and is centred on the software product and its role.
- IEEE 1490 accepts that the definition of **process** taken from the PMBoK Guide as "*a series of actions that*

[1] The Project Management Institute (PMI, USA) is the author of this general, but compact, definition; it has 200,000 members worldwide interested in project management in every type of sector; including computing, public administration, construction, chemicals, etc.

[2] PMBoK does not include the pre-contractual stage of tendering, which is adequately defined and developed in Euromethod, a European *de facto* standard.

[3] PMBoK is automatically edited as standard ANSI-PMI 99-001 together with the American National Standard Institute (ANSI) and the PMI. Standard ISO 10006, although not mentioning PMBoK, includes the same nine blocks or knowledge areas related to coordination, scope, time, cost, resource, personnel, communications, risk, and project purchase.

[4] The Institute of Electrical and Electronic Engineers (IEEE) is one of the largest *de facto* standardizing organizations in the ICT sector, and has negotiated the adoption of PMBoK with the PMI. It has not edited extensions or interpretations of PMBoK (as has occurred in the public administration and construction sectors) despite the fact that 40 per cent of its members are in the ICT sector.

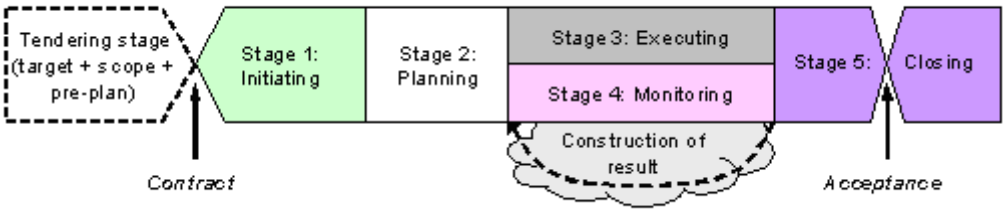

Figure 1: Project Management Life-Cycle Stages according to the PMBoK Guide (own development).

cause a result" is conceptually the same as the definition taken from IEEE 12207.0 as a "*set of activities – resource users – that are interrelated and transform inputs into outputs*".

■ IEEE 1490 notes that the definition of a **project** taken from the PMBoK Guide as "*a temporal effort begun to create a product or individualized service*" has semantic similarities at a conceptual level with **software project** taken from IEEE standard 1058 as "*a set of technical and management activities required to satisfy the terms and conditions of a project agreement*"[5] . It can be seen that the PMI definition is centred on the essence of the project, while the IEEE definition includes a description of the characteristics of the project.

The IEEE has also edited version 1 of the Guide to the Software Engineering Body of Knowledge (SWEBoK or "Ironman") [2] in parallel with the current version of PMBoK. The first five areas of knowledge in SWEBoK include the classic software construction cycle (requirements, design, construction, testing, and maintenance); while the other five areas include software project management tasks: configuration (6), engineering (7), software engineering management (8), tools and engineering methods (9), and quality (10). Specifically, the eighth area (software engineering management) in SWEBoK includes a sub-area of measurement, as well as a block in the other five sub-areas which resemble the management cycle stages in PMBoK, as seen below.

2 A Reconstructed Presentation of the PMBoK Guide

PMBoK enables a chronological structuring of the processes following the management task life-cycle; and grouping the processes in five stages, or process groups (see Figure 1).

The staged chronological presentation shown in this paper of the 44 processes involved in project management is more useful for teaching and professional purposes than the structure given in the PMBoK Guide, where processes are grouped into nine knowledge areas:

■ The seven processes of **Integration (I)** initiate all the stages to ensure that elements of the project are properly coordinated.

■ The five processes of **Scope (S)** identify the scope of work required to complete the project.

■ The six processes of **Time (T)** ensure timely completion of the project.

■ The three processes of **Cost (K)** ensure that the project is completed within the budget.

■ The three processes of **Quality (Q)** ensure that the project satisfies the needs for which it was commissioned.

■ The four processes of **Human Resource (H)** ensure the project makes the most effective use of the people involved.

■ The four processes of **Communications (C)** ensure timely and appropriate generation, collection, dissemination, storage, and ultimate disposition of project information.

■ The six processes of **Risk (R)** enable the identification, analysis, and management of the risks related with the project.

■ The six processes of **Procurement (P)** deal with the purchase of goods and services from other organizations.

3 PMBoK Initiating Stage or Process Group

The initiating stage processes require information from a contract or agreement resulting, in this case, from a pre-contractual stage not envisaged in the PMBoK Guide (see Figure 2).

The first process, **develop project charter (I1)**, supposes that the contract is accepted and the development of the project is authorized refining its assumptions, after the appointment of a project manager. The other process is the **development of a preliminary scope statement (I2)** and reflects the importance of identifying the scope[6] of the work and the deliveries required. This process begins with a **Project Management Plan (PMP)** which integrates the

[5] IEEE standard 1058 states that a software project should have specific start and finish dates, well defined objectives and restrictions, well established responsibilities, budgets, and duration. It may be self-standing or part of a larger project. In some cases, it may include only a part of the software development cycle. In other cases, it may involve many years of work and numerous software subprojects individually well defined and self-standing.

[6] The PMI defines scope as a set of products, services, and results, resulting from a project and the scope of a project as work performed to deliver a product, service, or result, with the specified functions and characteristics. Scope combines the coverage of the system (up to its frontier with the environment) and the depth (detail and granularity).

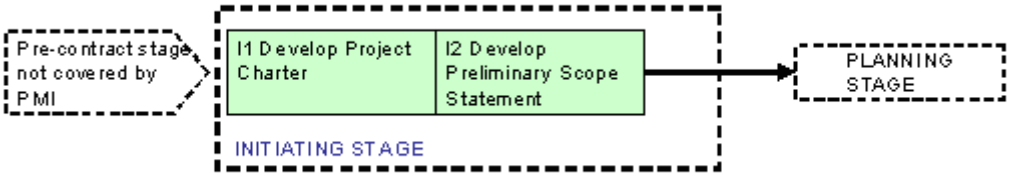

Figure 2: Project Management Cycle Initiating Stage (own development).

various subsidiary plans that will be modified by the successive processes in the planning stage, and which PMBoK considers to be the principal dynamic project document (see Figure 3).

4 Project Management Planning Stage

The planning stage is extensive and can be divided into four blocks of processes: identification-itemization; time-cost; other resources; and risk (see Figure 4):

- The **identification-itemization planning block** has six processes. Process **I3** for the **development of the project management plan** begins the actions that define and coordinate other PMP subsidiary plans (generated by the processes termed "… planning" and shown in Figure 4). The successive processes reflect the acquisition of a better understanding of client requirements than that obtained in the pre-contractual stage. These include identification of requirements, opportunities, acceptances, restrictions, and risks, together with new interactions between tasks that depend on the nature and progress of the project. The probable changes over the course of the project, brought about as much by the requirements of the client as the resources of the supplier, require a reiteration of the planning processes, thereby updating the PMP with a repeated process of gradual planning until the final plans are identified.
- The **time and cost planning block** estimates the duration of the activities itemized and defined in the previous block, as well as the costs incurred to achieve these activities. The scheduling of these costs as part of a budget, and the durations as part of a timeline, will give an initial planning approximation. This estimation will be subsequently adjusted by the other processes of resources and risks in the various subsidiary plans of the project management plan for human resource, communications, purchase and acquisitions, quality, and risk management.
- The processes of time and cost will differ in their objectives when handled from the point of view of supplier or client, the client being primarily interested in predicting the potential financial performance of the product. In any case, for both the supplier and client, the estimation, viability, planning, and monitoring of costs, is one of the most difficult and crucial functions for the project manager, and is the main cause of failure and project abandonment.
- The **other resources planning block** basically reflects the delicate problems of human resource related to the formation of the working team, the profile of the individuals, and the relationships and abilities that are key to the success of the project. This includes contracting external resources, and overall quality management should monitor the purchased components and their integration in the task of achieving the desired product.
- The **risk management planning block** implicitly follows the general model of risk analysis and management developed in other sectors, particularly the ICT sector. In this way, the objective of project risk management is to review the possible impact of events that may affect success or the fulfilment of objectives and so minimize adverse events while increasing positive events. Technically, when the critical risk factors in the project (unlike the Critical Success Factors or CSF) are known in advance, they are analysed and placed on the timeline so that responses can be generated that anticipate, or at least mitigate, the effects. However, those unknown risks that appear during the development of the project cannot be proactively managed in advance in an individualized manner. It is therefore worth assigning a reserve of assets and resources to reduce these

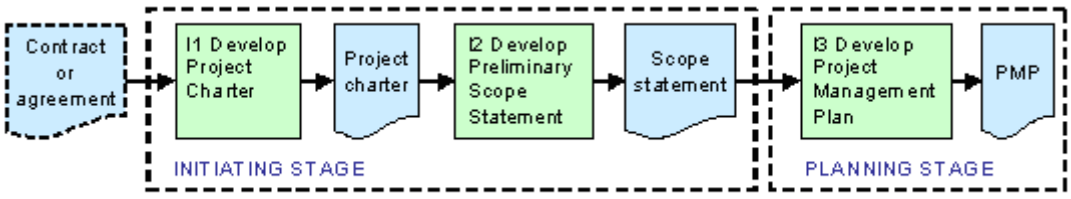

Figure 3: Inputs, Processes, and Outputs in the Initiating Stage (own development).

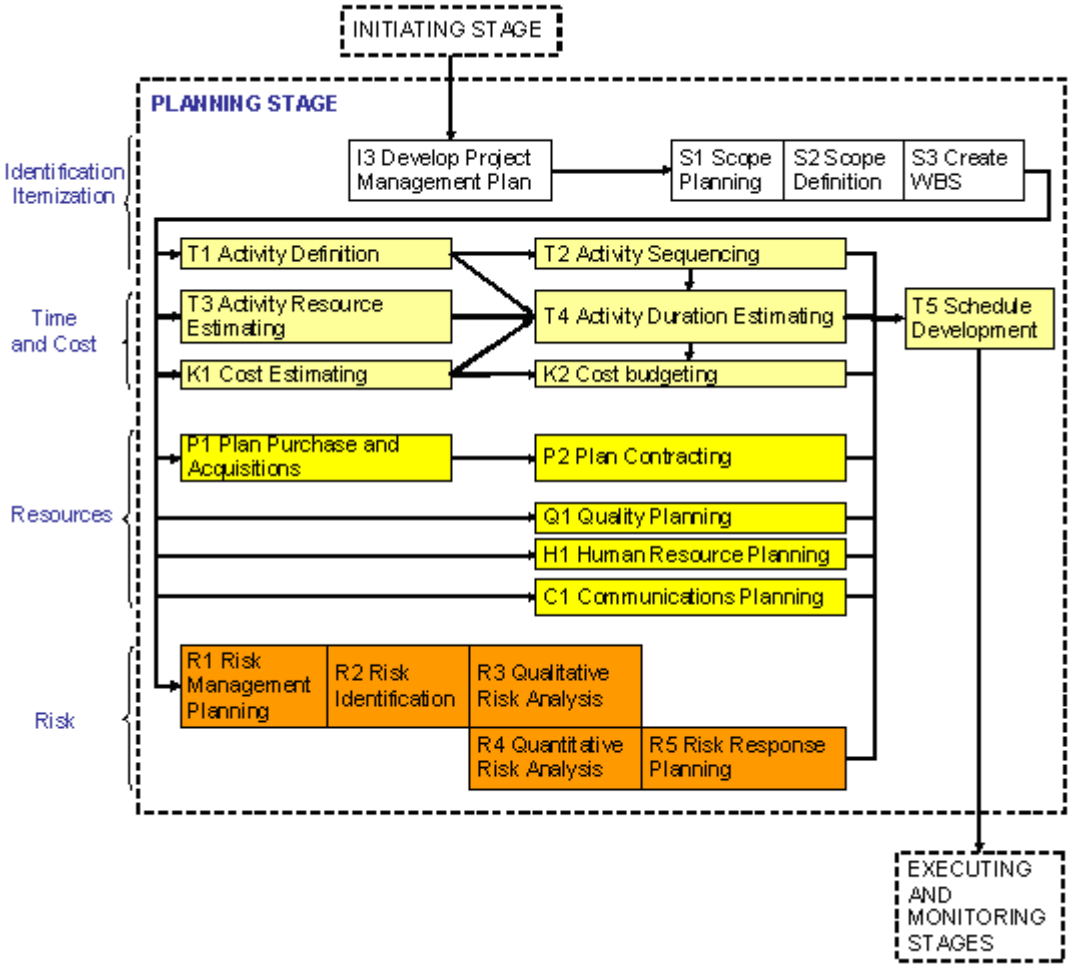

Figure 4: Project Management Cycle Planning Stage (own development).

risks. The PMBoK Guide says that psychologically organizations have attitudes towards risk that determine their exact perception of risk and how they respond. These attitudes should be explicit wherever possible. The responses to risk reflect the equilibrium in an organization between taking and avoiding risk. In any case, the known (however complex) can be anticipated, but the unknown cannot be anticipated. If an element of unknown risk exists, then resources must be reserved for the increasingly important monitoring stage.

5 Project Monitoring and Controlling Stage

This stage is developed in parallel with the execution stage, which is assigned to the project manager, and the result production stage undertaken by the managed team[7]. The project manager observes the development of the project and the construction of results in order to identify and rectify problems. His role has two functions: to regulate any deviations from the project management plan and its performance base, and to include any changes requested and actions recommended to reduce existing deviations and to prevent future occurrences.

This dual activity is achieved in two processes (see Figure 5). On starting the **direct and manage project execution** process (**I4**), the data from construction must be collected and an additional effort of concentration is required. The final process of **monitor and control project work** (**I5**) does not originate in the decisions generated by the project, and this implies a discontinuity in the changes. This discontinuity tends to induce a profound revision of construction[8]. Both processes facilitate feedback for the corrective, or preventive, actions in the following sub-cycles:

[7] Two PMBoK processes have been interchanged between the stages of monitoring and execution to clearly separate both functions, as well as changing their order so as to completely sequence various activities that PMBoK develops in parallel and whose start is irrelevant.

[8] A discontinuity linked to the change would be the most coherent way to deal with the project, but the PMBoK Guide offers a single presentation without discontinuities and this will especially affect the monitoring stage.

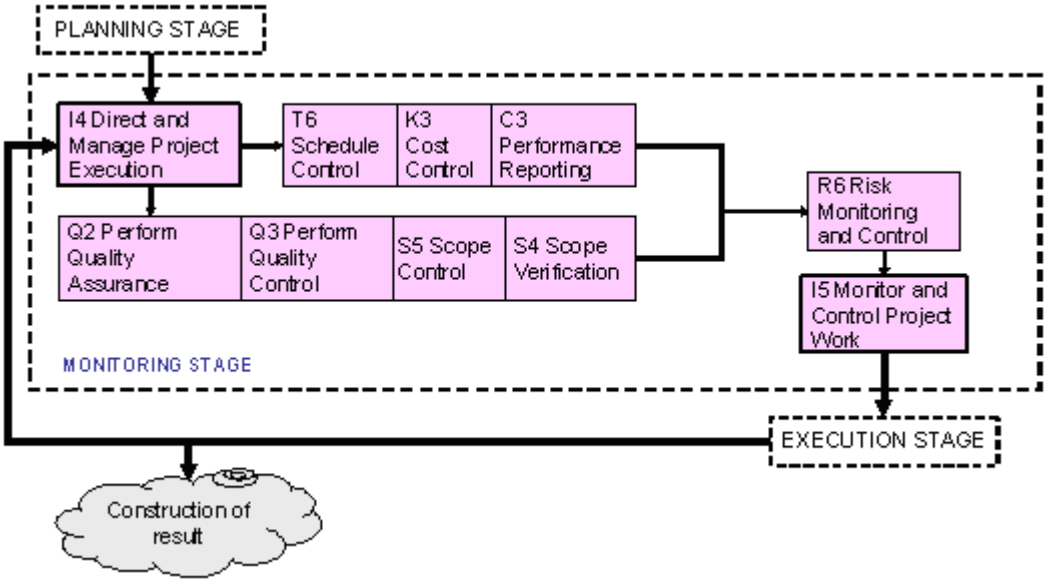

Figure 5: Project Management Cycle Monitoring Stage (own development).

the sub-cycle "do-check-act" progresses according to the project life-cycle; the sub-cycle "do-check-act-plan" is a regression to the planning stage and re-launches the life-cycle as a sub-project of the previous one, or even a new project.

The organization of the monitoring tasks in this chapter follows a dual criteria. All the processes are formally sequenced, following an input/output flow model that postpones changes in order to integrate them into a final process with a structure that enables the computerization of the processes that transform the flow. This homogenizes the contents in two general lines, dealing with time and cost variables (obtained from construction and exploitable with indicators on the progress of the project), and the procedures related to scope and quality. Both these lines end in the process of **risk monitoring and control** (**R6**), prior to preparing actions and integrated changes that respond to these risks. Monitoring is a set of processes repeated when deviation or change is detected. It aims to simplify everything because, as Frame rightly comments, even a minor change in a small task requires 15 or 20 affected agents to be notified.

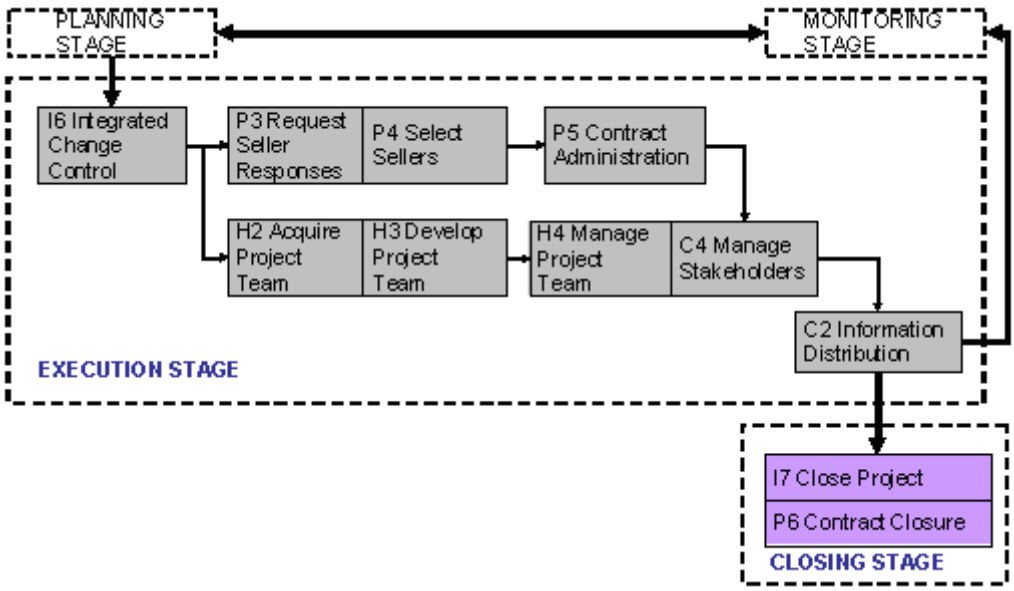

Figure 6: Project Management Cycle Execution and Closing Stages (own development).

6 Project Execution and Closing Stage

During the execution stage, the project manager tackles the delicate processes associated with human resource selection (internal personnel) and contracting (external personnel), with complementary and different functions to those of the managed team.

In the closing stage, after verifying that all processes are completed, the project manager finalizes the activities of the contract and closes the project either through product delivery or cancellation (see Figure 6).

7 The Ease with which Different Projects can be Planned

The methods of project management can be characterized by the relative range given to the planning stage, and increasingly the monitoring stage (compared to the initiating, execution, and closing stages, which every process must also logically include).

It can be seen that the planning stage includes half the PMBoK processes. This range reflects the fact that many projects can be planned; that is, the future can be seen with reasonable accuracy, so it is reasonable to dedicate effort in this stage. Predictable problems can be prevented during the viability studies in projects with well-defined albeit complex objectives. This is achieved by selecting the appropriate technical, economic, and organizational alternatives.

In the times in which we live, when change occurs quickly, it is not always possible to define the objectives of a project precisely. As a result, projects are started with provisional objectives, for an uncertain period of time, and with a dependent and provisional planning; that is to say, a shallow project that does not merit as much effort as in the previous case during the planning stage. The corresponding effort is then transferred to an increased risk management and more careful monitoring stage. This effort is made in the hope (generally confirmed) of being able to react to problems as the project advances. It is often possible to define clearer and more obtainable objectives with the help of decisions that reasonably modify the current plan.

8 Organization of Project Management Processes

Interactions between the processes of project management follow the classic cycle of "plan-do-check-act" attributable to Deming, in order to increase the result quality iteratively. In the central part of the three project stages (excluding the project initiating and closing stages) the planning stage corresponds to "plan"; the execution stage corresponds to "do"; and monitoring and controlling corresponds to "check and act", the processes of which also interact with all the others.

The processes of PMBoK are presented with well defined interfaces, but in practice, they also interact. Project management is an integrated task that connects each process with others, and balances the objectives and requirements of the project. In this way, a large or complex project usually contains processes that must be repeated several times to define and satisfy the requirements of the stakeholders, and this normally affects the process in question and the other related processes. For example, a change in the scope almost always affects the project cost, but such a change may, or may not, affect team motivation and product quality. The application of processes is repetitive, and many processes are reiterated and revised during a project.

References

[1] Project Management Institute. A Guide to the Project Management Body of Knowledge (PMBoK Guide, 3rd Edition). PMI, 2004. ISBN: 1-930699-50-6.

[2] IEEE Computer Society. A Guide to the Software Engineering Body of Knowledge, SWEBoK (Ironman). IEEE 2004. <http://www.swebok.org/>.

