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Design and development of a support tool for Earned Value Analysis of a turnkey Agile project: Amarìs use case

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Amaris Is Srl

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ABSTRACT

In this thesis work Project Management for IT projects is analyzed and revisited. Amarìs Torino, the consulting company in which the thesis was developed, is a pioneer of a new way of working for consultancy: the delivery of turnkey projects.

This type of contract gives space to new dynamics between *Contractor* and *Client* and must adapt well to every approach to work. The relatively new Agile development team is settling in, while the PM needs to merge the discipline of Project Management, rigorous monitoring practices, with the flexibility of Agile implementation.

A support tool has been created for the Project Manager to facilitate Earned Value Analysis as a method for monitoring the work of the various teams coordinated by him. The tool was tailored and tested during a project.

In taking charge of the project, a hybrid approach between Agile and Waterfall methods was suggested. Furthermore, the minimum documentation standards to be drawn up have been imposed, in order to have the most accurate planning as possible. This also allowed performance analysis to have added value for future projects.

The results were discussed time after time, during each monitoring date, thanks to the support tool created, and this allowed the PM and the team to achieve excellent delivery results.

PREFACE

In this chapter the reader is introduced to the environment and the industry in which this thesis has been developed: IT consulting.

The study, learning and input of this work can be traced back to the host company Amaris, a consultancy company in various fields, which mainly deals with IT projects in the Turin office. The aim is to enhance the Earned Value Method in project management and to verify its outputs on a real case: creation of a web application according to some frames of the Agile approach.

The theory of Project Management cannot therefore disregard the *modus operandi* of the company, the approaches used, the projects type taken in charge. Conversely, the business pursued by companies in the consulting industry influences new Project Management practices and gives rise to new approaches.

IT CONSULTING

IT consultancy means a professional service provided by one or more experts in the IT sector.

The IT (Information Technology) services structure of a company defines the winning strategies to increase the efficiency of both internal and external processes and corporate communication processes, with a consequent increase in turnover. The IT infrastructure involves major investments in maintenance and periodic updates.

In most cases the human resources within a company are professional figures closely connected to what is the core business of the company. Operating activities in information technology are then managed in outsourcing by specialized consulting companies.

Main Services and Industry

The main IT services provided by consulting companies are:

- Development of customized software, following a feasibility analysis and drafting of a commercial proposal for the client company;
- Customization of a software purchased from a third-party software company according to very specific characteristics;
- Creation of customized software with respect to an information system within which it must be integrated;
- Active collaboration on site and remotely for software and application maintenance;
- Advice on optimizing the use of the existing IT system;
- Enhancement and support to the client's structured work group for the development and integration of a business software;
- Creation of individual modules, existing software plug-in components to expand their original features;
- Bug fixing, research and error correction, for the efficiency of the software already in use by the client company.

IT consulting is part of the broader area of management consulting, which includes Strategy, Finance, Risk Management, Operations. The area of IT specialization, considering medium and large consulting company players, represents the widest slice of Management Consulting in Italy (30% of the total industry).

In 2019 the consulting services in support of the Digital Transformation - especially in the case of large companies - were one of the main drivers of growth in the sector, through the acquisition of targeted companies or the creation of specific divisions and teams. In the Digital area, the consulting companies develop projects to redesign business projects, sometimes carrying out also change management and staff training activities.

The digital technologies that the consulting company most frequently manage in their interventions are linked to Industry 4.0 (IoT and automation processes) as well as Big Data and Advanced Analysis. At the same time, crossing this data

with the analysis of innovative consultancy proposals, it emerges how the growth in consulting support for the Digital Transformation has contributed to the launch of projects in the various functional areas. Nowadays Functional consulting and IT are the most requested area of expertise in the Italian market (37%).[1]

The host company Amarìs Turin

Amaris is a global consulting company that provides services and technological solutions. It has over 6,000 employees in over 50 countries.

Figure 1 - Amaris Company Data [2]

For IT and Digital area Amarìs Turin offers consultancy and IT services in technological strategy, application management and infrastructure services. At the Turin office, the management of projects in the delivery mode is innovative: the contracts stipulated with customers are turnkey contracts (fixed price, remote implementation). In monitoring the activities, delivery managers begin to use

[1] From B
[2] From J

the Earned Value Analysis, a method that allows to evaluate the work efficiency during the project progress, and not at its end.

The COE (Center of Excellence) for the digital area offers microservices, mobile applications, customized software, web applications.

Figure 2 - Amaris Digital Services[3]

The newly formed COE team is trying to follow an Agile approach in the implementation of the products commissioned by different customers. It was therefore necessary to provide support tools suited to the managerial area in order to deal with different work groups with different work methods. The case study concerns Startup Your Life, a three-year path that offers learning opportunities through an innovative online platform. The team tried to follow

[3] From J

some frameworks of the Agile approach and the project manager used the Earned Value method to monitor the project and to better reallocate resources.

1 IT PROJECTS

This chapter goes over the concept of Project. Starting from defining when a set of activities can be called a project, it is possible to define what are the characteristic elements of a project.

Given that the object of the thesis is the management of a Turnkey project in the IT area, in this chapter is explained specifically what an IT project consists of, and the main approaches used by the host company.

IT projects consist of creation of computerization systems or web platforms, software development, generally classifiable as: system; scientific (focused on calculation); real time (with precise constraints on response times); embedded (appliances, traffic lights); for PC / Tablet / Smartphone; business information systems; operating systems.

The discussion uses the word “software” generally, as IT product.

1.1 PROJECT DEFINITION AND WORK APPROACHES

"The project is a temporary initiative undertaken to create a unique product or service".

(PMI)

The term project refers to a complex, single enterprise with a fixed duration, aimed at achieving a clear and predefined objective through a continuous process of planning and control of differentiated resources and with interdependent constraints on costs, time and quality.

Regardless of the field and scope, all projects share key elements that define them as such:

- Temporary nature: a project always has a pre-established beginning and end, therefore a predetermined duration;

- Specificity of the objective: a project is aimed at producing a unique result/product;
- Specific resources (time, money and people) assigned;
- Development in phases: beginning idea, planning, implementation, end;
- The employment of a team of professional figures;
- Monitoring and adaptation activities to ensure the achievement of the goal.

All projects follow a path divided in distinct and subsequent phases that start from the initial idea of developing a product, and end with its realization. The life cycle of a project is characterized by five phases that connect the beginning and the end:

1. Start, in which the objectives, the recipients, the work plan, the products, the expected results, the partners, the times, the places and the resources are determined. This phase ends when the main aspects of the project are outlined and shared by the project team through a document, the Project Charter.
2. Planning, in which the structure, strategy, process and resources necessary for the realization of the project are detailed. In this phase, the project idea is analyzed in all its aspects and broken down into a definitive plan of the activities to be carried out, determining time, team and budget constraints.
3. Execution, which is configured as a process of activities aimed at following the plan and the set objectives. Some activities are continuous throughout the project (such as management, communication, monitoring and evaluation), while others are a constituent part of the specificity of the project and its originality.
4. Monitoring and control during the entire life cycle, in order to verify that actual progress accomplishes with the planned one;

5. End, which is intended as delivery of products / services and administrative closure of the project. The administrative end of the project is the phase in which the work done for the future is capitalized with the recapitulation and the sums of the entire path.

In IT projects there are different approaches to be used:

- Waterfall;
- V Models;
- Iterative.

Mainly Iterative and Waterfall approaches are used. The most used iterative method is the Agile one, which is replacing Waterfall approach in the Software Engineering.

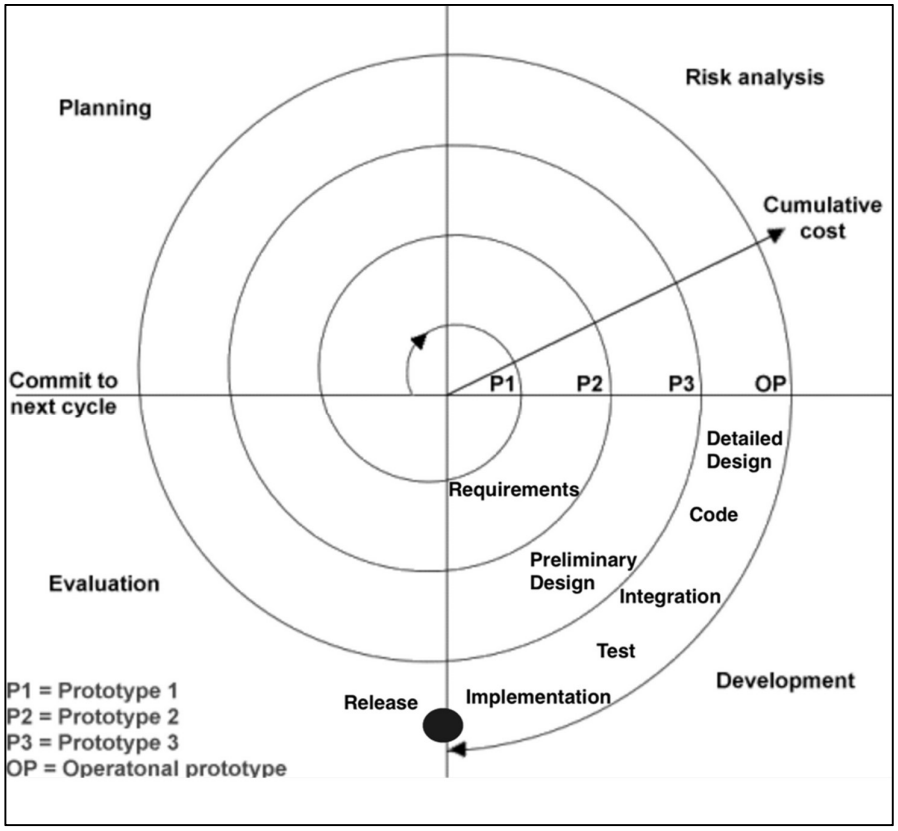

Figure 3 - Example of Iterative Model (Spiral Model)[4]

There are great differences between Agile methodologies and Waterfall methodologies. The first method gives space for flexibility and changes, the second one is more rigid and rigorous. The Waterfall method is based on a well-defined sequence of macro-steps: it is not possible to move to the next step without having finished the previous one. Moreover, notice that in every phase the output produced will be the input for the following phase.

Waterfall is the method to be followed for projects with defined budgets and times in which the actors involved are many and there is a need for a greater structuring of the activities. The positive side is given by the fact that there is a

[4] From I

unique structure of activities and timing to which each group refers. The documentation generated in the various phases is fundamental because, in this way, the eventual loss of a team member would not also cause the loss of knowledge since the latter would be all contained in the documentation. It is enough that the resource to which will be assigned to a new assignment consult the various documents for become familiar with the project: internal documentation and knowledge are preserved.

However, the delay of a single task adversely affects the timing of all other activities, which will also be delayed. A negative aspect is also testing only the finished product: it may happen that the clients or end users are not satisfied, at the end of the project, with the implementation of the final product / service. Sometimes, the client is not very clear about the requirements at the beginning and by using this methodology making changes is impossible. The whole process is sequential and there is no possibility of revisiting the previous phase. So, the model appears to be too rigid for particularly complex projects.

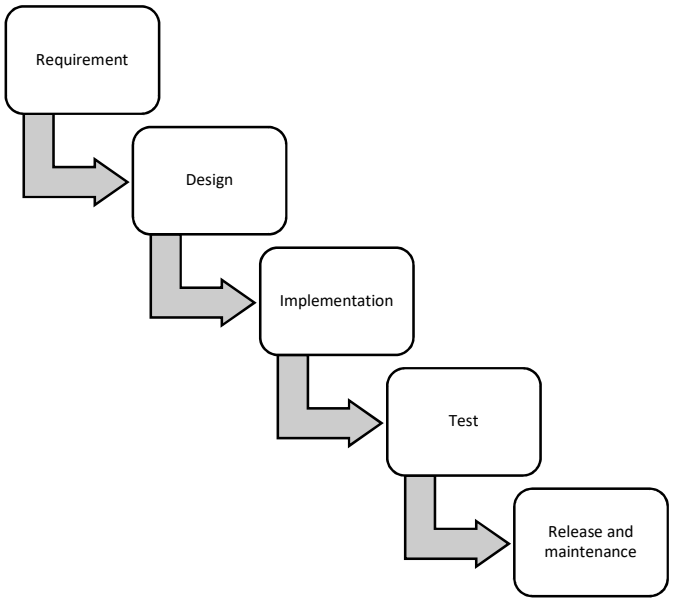

Figure 4 - Example of Waterfall Flow Chart

The Agile method can be pursued under more flexible conditions, where the focus is mainly on business needs. In a broad sense, the term *Agile* indicates

development methodologies based on a collection of specifications and on a structuring sequential software development. The agile methodologies allow instead to continuously review the specifications, adapting them during the progress of software development, through an iterative and incremental framework, and a strong exchange of information and opinions between the developers and with the client.

1.2 AGILE SCRUM

Agile is focused on adapting to the changes and to the needs that emerge in the day-by-day projects, characterized by short-term planning. Scrum is the most popular Agile method: it is a framework which divides the project management process into sprints to coordinate the product development with the needs of the client. The theory behind this method is that of empirical process control (empiricism), according to which, on the one hand, knowledge derives from experience and, on the other hand, decisions are based on what is known. For this reason, the process is iterative with an incremental approach sprint after sprint.

The main components of Scrum are divided into roles, artifacts and events.

1.2.1 Roles

There are 3 roles defined within the Scrum Team, which are in connection to ensure a continuous and fast flow of information.

- SCRUM MASTER: the person in charge of the process, the one who must ensure that the Scrum methodology is successfully understood and executed. He must ensure that the team works consistently with the development of the project, organizing and facilitating team meetings.
- PRODUCT OWNER: who knows all the product requirements and carries out the interests of all stakeholders. The interface between the customer on the one hand and the development team on the other.

- DEVELOPMENT TEAM: the group of cross-functional and self-organized professionals, the number of which usually remains from 5 to 9. It deals with product development and functionality testing and is responsible for organizing priorities by transforming them into task to be completed to complete that sprint.

In Team Amarìs the roles of the Scrum practice are not properly adopted. Now there are only three COE members who try to adopt an Agile methodology and none of them assume the role of Scrum Master. Therefore no one takes charge of making the Scrum methodology fully understood and applied. In addition, the team is still supervised by a Project Manager in defining scheduling and deadlines, a figure not covered in the Scrum. Despite the figure of the PM, however, the team can prioritize the work and define the tasks related to the requirements almost autonomously.

1.2.2 Artifacts

There are three artifacts, designed to maximize the transparency of key information (both for the Scrum Team and for all stakeholders) and the opportunity for inspection and adaptation.

- PRODUCT BACKLOG: the document containing the list of all the requirements necessary for the realization of the project. The Product Owner is responsible for its content, its availability and the ordering of its elements based on their respective priority.
- SPRINT BACKLOG: the document that defines all the tasks to be completed in the individual sprints. It is a forecast made by the Development Team in relation to the priorities indicated in the Product Backlog and the work necessary to achieve the goals of the sprint.
- INCREASE: the sum of all elements of the Product Backlog completed during a sprint and during previous sprints. At the end of the sprint, the

increase must be made based on what has been agreed by the Development Team to guarantee a usable product.

Even in the case of artifacts, these documents are not written by the team actually. In the study of the management of AS IS projects in the Amarìs company, the team uses a Kanban board as a support tool for Agile development. Therefore, Scrum artifacts in their strict sense are not used.

1.2.2.1 Jira Support Tool[5]

Jira is a software to facilitate the application of Agile methodologies in the team. Through the Kanban[6] dashboard the team creates user stories and tickets, plans sprints and distributes the tasks within the software team. The team can prioritize and discuss work in the global context with full visibility, as each member has access to information "in the cloud". Each team follows a unique procedure for software release. The Agile team either uses a predefined workflow or can create a custom one based on the work mode. Each item passes from one state to another, then from one artifact to another. The basic flow used by the Amaris team is the following one:

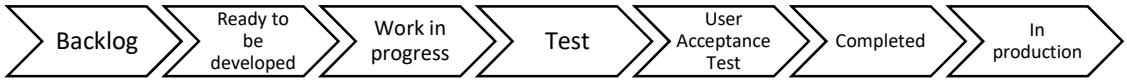

Figure 5 - Jira Kanban Board Status

The Kanban Board method allows to achieve the objectives through the visualization of the processes: each item passes from one column to the next and communication is enhanced. The Client also has access to the platform (this to endorse the constant presence of the customer during all the project phases in

[5] Information from limited access to the Work Dashboard
[6] A Kanban board is an Agile project management tool designed to help visualize work, limit work-in-progress, and maximize efficiency

Agile) and can comment, request assistance, make new requests, in compliance with Continuous Integration Continuous Deployment value.

An inconsistency is detected in using a Kanban board rather than a Scrum board, which would have been more rational with the Agile Scrum frameworks to which the team refers.

1.2.3 Events

There are four formal events used in Scrum (with a fixed duration) to create regularity, synchronize activities and minimize the need for undefined meetings. The aim of these events is to allow critical transparency and inspection on the progress of the project.

- SPRINT PLANNING: the meeting where the Product Owner drew up the Product Backlog and, in the presence of the Development Team and the Scrum Master, describes the most important items and the objective to be achieved in the following sprint. At the end of the meeting the Scrum Master can fill in the Sprint Backlog.
- DAILY SCRUM: a brief daily comparison (lasting 15 minutes) between the Development Team and the Scrum Master, who notes the work done the previous day and creates a plan for the next 24 hours (until the next Daily Scrum) to predict and synchronize activities.
- SPRINT REVIEW: a review at the end of each sprint to evaluate whether the set goal has been achieved and with what results. The whole Scrum Team participates and, in addition, the customer of the product, who will be shown the work done up to the sprint.
- SPRINT RETROSPECTIVE: a further retrospective analysis carried out with the participation of the entire Scrum Team to evaluate what to continue doing, what to stop doing and what to improve in the next sprint to obtain even more efficient performance.

The development team in Amarìs Torino does not adopt these formal events in their entirety. It must be underlined, however, that adopting a pure Scrum is difficult given the western Italian cultural aspects, very far from the oriental culture where these practices were born. Furthermore, in consultancy with turnkey contracts it is necessary to reconcile different figures / roles and in various events.

The team is loyal to Sprint Planning and Sprint Review, while the Daily Scrum and especially the Sprint Retrospective are absent practices.

1.3 HYBRID APPROACH

The teams involved in agile projects play a central role since everyone is responsible for a series of tasks linked together according to specific objectives and times. However, when a team has just been formed and relatively inexperienced, especially in a large company where the steering committee must be reported, it is difficult to manage the work purely in Agile. The on-site project manager also has several teams in charge which in turn are in charge of different projects. They should self-sufficient and self-managed, led by a project manager.

For projects involving mobile applications and web services, a sprint is estimated approximately every two weeks, for a total of about four to five sprints. The consultants decide for each sprint what to implement. Each sprint is therefore the release of later versions to be tested, each time with additional features. Working with a short-term view allows the team to add or delete tasks based on needs.

The methodology is based on optimizing time and human resources in order to produce the value and results agreed with the customer: the customer is responsible for defining priorities and deadlines. The entire process is customized and adapted to customer's needs. The customer has access to the progress of the project, having full control. The Kanban dashboard on Jira allows

the team to stay in touch with the customer, provide transparency and maintain lean communication. However, the adopted tool Jira licensed is not suitable for project monitoring by the delivery manager. For this reason, a solution is found that would meet these needs.

Among the positive aspects of the Agile approach, there are incremental requirements, the aim pursued in a continuous and iterative manner, adaptation to change. On the other hand, the work is not very structured, the workflows are less clear, and the documentation is approximate or sometimes absent.

In IT projects with turnkey contracts (fixed price), the tendency is to combine both approaches. The hybrid approach proposed consists in having a Project Manager to help the Agile roles, initiate the project and make the long-term planning using the traditional approach. The Project Manager also monitors the performance. So, a hybrid approach has the Agile roles on the technical side while the Project Manager on the management side. It is advisable to:

- Use an iterative approach to break up large projects into smaller chunks, develop the high-level requirements and plan upfront, and continue to refine the requirements and plan with each iteration;
- Prioritize requirements to ensure that the most essential requirements are done first to accelerate the delivery of the most important capabilities;
- Develop a higher level of engagement of business users in the oversight of the development effort and develop a more flexible and adaptive approach to requirements definition if necessary;
- Integrate Quality testing into the development effort and adopt the agile principle that deliverable is not "*done*" until it is tested;
- Use agile/lean technical practices to improve development productivity: integrating all Scrum practices together.

2 SOFTWARE QUALITY AND DOCUMENTATION

It is a well-known fact that software documentation is, in practice, poor and incomplete. Documentation does not exist in a complete and consistent form in most organizations. When documents are produced, they tend to follow no defined standard and lack information that is crucial to make them understandable and usable by developers and maintainers. The documentation is often perceived as too expensive, difficult to maintain under the typical time pressures that are pervasive across the software industry.

In this view, a tradeoff must be found between the level of detail and scope of documentation, the frequency with which it is updated, and the cost of its development and maintenance. It is better to understand what type of documentation is required, what is needed to support its completeness and consistency, and what is the level of precision required for each type of document. These questions cannot be investigated at that level of generality though. Answers are likely to be very context-dependent to be precise.

In the Project Management discipline, the preparation of documents must be taken into consideration. As explained above, there are key documents that cannot be ignored at every stage of the project life cycle. The presence of accurate and detailed documentation determines the quality level of the finished product. It is also a protective tool against problems with stakeholders and in the case of Knowledge-Transfer activity.

It is difficult to compound a versatile and free approach, as the Agile one, with the activity of drafting documents, rigid *per se*.

For this reason, the thesis focuses on IT projects regarding microservices, web services and mobile applications. In particular, focusing on *Quality Assurance* and documentation in projects implemented with an Agile hybridize approach.

2.1 PROVISIONS

To formulate a *to be* documentation report that is suitable for the team's Agile working methodology, the following documents have been studied as guidelines.

2.1.1 ISO 9001

ISO 9001 is a quality management system standard for internal application, focused on the effectiveness of the quality management system in meeting customer requirements.

In the paragraph 4.2.1 of the ISO 9001 standard it is stated that *"the quality management system documentation shall include [...] documents, including records, determined by the organization to be necessary to ensure the effective planning, operation and control of its processes"*.

These guidelines disregard the product / project to be implemented and also disregard the approach used. The extension of this documentation may differ depending on the size of the organization, the critical nature of the activities to be performed, the complexity of the interaction of the processes, and the competence of the personnel. For instance, an IT project in Agile of around 100 man-days, even if apparently not complex, cannot absolutely exclude a documentation at least regarding the requirements collection. Using the hybrid approach as described above, without proper documentation the project manager cannot plan and monitor activities and relationships with the client may become complicated.

The ISO 9001 standard also establishes a continuous control and updating of the documentation (ISO 2008 - 4.2.3). The documentation must be available for each phase of the project. Agile teams in large companies often tend to prepare documentation only for an initial contractual phase. The documentation is important also in design and development phases. The outputs of design and development shall be in a form suitable for verification, in order to be easily

approved prior to release. The documentation of these phases should be coherent with the one of requirements collection.

Moreover ISO 9001 provides guidelines on measurement and monitoring, but also on improvement, such corrective and preventive actions.

2.1.2 ISO/IEC 12207 International Standard

ISO/IEC 12207 establishes a common framework for software life cycle processes, with well-defined terminology, that can be referenced by the software industry. It applies to the acquisition of systems and software products and services, to the supply, development, operation, maintenance, and disposal of software products and the software portion of a system. It is therefore a fundamental reference for the realization of an IT project and has been used and examined for the case study of this thesis.

Reference was made to the fifth chapter, which deals specifically with the life cycle of a software and the software implementation processes. Note that this International Standard, like ISO 9001, is also applicable to any project regardless of the work approach, schedule, team organization. The processes for the following Software-related activities are defined:

- Implementation;
- Support;
- Reuse;

In this standard also, Software Support Documentation Management Process stands out in the support activity.

Principle 7 of the Agile Manifesto states: "*Working software is the main measure of progress*". It is true that documenting is important, but the most important thing is that the released software satisfies the customer. If the scenario changes, the software changes and the documentation is to be rewritten. Often this is unfortunately translated into "the working software is more important than the exhaustive documentation" and it seems that the priority is

instead on the software. Care must be taken not to confuse the main progress measurement with the priority. The need therefore arises to explain the importance of basic documentation even in an Agile work environment.

The compromise that the team is invited to adopt in the Amaris hosting company is to document and keep track of every phase of the software life cycle.

2.2 SOFTWARE LIFE CYCLE[7]

Software Life Cycle represents how a development methodology breaks down the activity of creating software products into coordinated sub-activities.

Almost all software life cycle models include a breakdown of the development process into sets of similar activities. The distinctions between different life cycles are highlighted on other aspects, such as:

- the relative emphasis attributed to each activity;
- the identification of the specific actors in charge of each activity;
- the order in which the activities take place.

In all software life cycles, the documentation of the products of the various sub-tasks also plays an essential role; the drafting of the documentation is therefore regulated in the same way as the activities mentioned. The software development phases are:

1) Analysis;
    a) Requirements clarification
    b) Requirements analysis
    c) Domain analysis
2) Design;
    a) Architectural project
    b) Detailed project

[7] From ISO/IEC 12207 International Standard

3) Programming;
4) Inspection;
    a) Debugging
    b) Testing
5) Release and Maintenance.

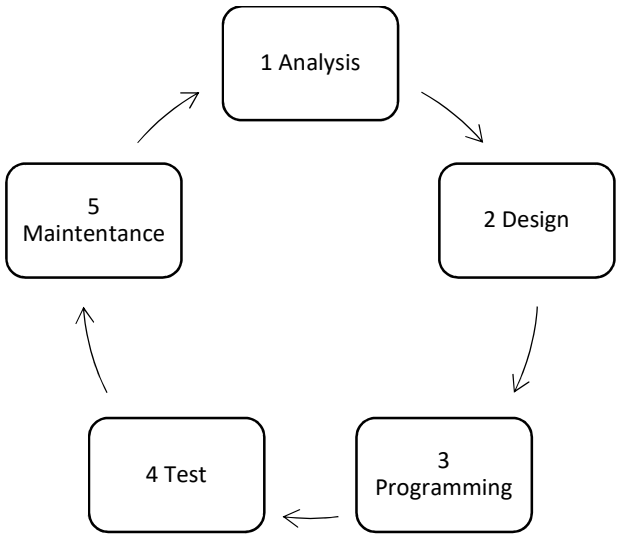

Figure 6 - Simplified Software Life Cycle

The AS IS study of IT project management for the COE team shows that the documentation is disordered or absent, as the Jira tool does not allow the minimum degree of formality necessary for a company of this size. A set of TO BE documents was therefore decided to be drawn up, based on problems encountered in the months of observation. Software documentation shall include at least:

- Requirements: these are declarations of attributes, capabilities, characteristics and quality of the system;

- Architecture and Design: this part provides an overview of the software by introducing the relationships between the environment and the development principles used in the design of the components;
- Technical documentation: includes the description of the code used to implement the project, the algorithms and the APIs;
- Test carried out by the developers and by users;
- End user: contains staff explanations and the user manual.

This documentation must be drafted independently of the Jira dashboard, in a formal and rigorous manner. In the Agile implementation is often used a Kanban Dashboard from which it is possible to deduce who carries out what and with what technology. But if the requisite and test documents are missing, the quality of the work can be considered scarce and the project management and monitoring activity becomes impossible. With the support of the expert consultant in Quality Assurance, specific templates have been prepared for the COE team. A high level of detail is not required, as according to the rules the documentation is related to the level of risk of what is implemented.

SRS, or Software Requirement Specification, is a document prepared by a team of system analysts that is used to describe software that will be developed, the main business purpose and functionality of a certain product, and how it performs its core functions. An SRS is a basis for any project as it consists of a framework that will be followed by each team member. An SRS is also a base of a contract with stakeholders (users/clients) that includes all the details about the functionality of the future product and how it is supposed to run. An SRS should be used by software developers during the process of product or program development.

Testing documentation involves the documentation of artifacts that should be developed before or during the testing of Software. Documentation for software testing helps in estimating the testing effort required, test coverage, requirement tracking/tracing, etc. A great difficulty was encountered in the testability of

some mobile applications due to confusing documentation and lack of exhaustive description of use cases. some of the commonly used documented artifacts related to software testing such as Test Plan, Test Scenario, Test Case, are suggested to the team, endorsed by the expert consultant in Quality Assurance.

Good project management and work methodology can be assessed by the presence or absence of these two documents: requirements and tests documents. In fixed price projects, the contractor assumes the entire risk. This is why in IT consultancy pure Agile is not adopted as a work methodology. There is not possible to have an excessive level of flexibility. The documentation listed above is necessary in the event of customer dissatisfaction. If the requirements have been written down and documented, further customer requests not included in the agreement are avoided. If the test methods have been disclosed and the outputs of these tests have been documented, any future malfunctioning is not the responsibility of the supplier company.

In the Information Technology sector, the concept of *KT* (Knowledge-Transfer) is very current and widespread in software projects. It is to be considered an established culture that aligns with the training of personnel. The Knowledge-Transfer consists of a long period in which the experts confer the key competences for the inclusion of the new resources/consultants in the project. It means the transfer of both the domain and the technical / technological aspects.

The Knowledge-Transfer begins with a methodology set by the figures who have already experienced the implemented project. Risks, errors, procedures and solutions are documented in technical manuals whose level of detail is usually high. Since in the consulting work environment there are frequent changes of resources and agreements with new contracting companies entering into the contract, this practice is quite frequent. For this further reason the documentation is of fundamental importance.

2.2.1 Software Quality

Software quality is a constant field of application throughout the software life cycle.

The quality of the software means: the extent to which a software product meets a number of expectations with respect to both its operation and its internal structure.

Much of the research in the field of software engineering is dedicated, directly or indirectly, to the issue of quality. In particular, to establish clearly what is meant by software quality, it must be defined:

- a set of significant quality parameters;
- to implement techniques to measure these parameters with respect to a given software system;
- to develop technologies (for example programming languages) and methodologies (for example of analysis and design) that facilitate the creation of quality software.

Traditionally, the parameters (or factors) with respect to which the quality of the software can be measured or defined are classified into two families: external parameters and internal parameters.

The external parameters refer to the quality of the software as well as perceived by its users, and include:

- Correctness: A software program or system is said to be correct if he behaves exactly according to his own requirements specification.
- Reliability: A system is all the more reliable the more rarely, during its use, malfunctions occur. On non-critical applications it is considered to be economically advantageous the release of unreliable products but equipped with periodic patch loading mechanisms (for example via Internet) through which errors are corrected as they are found by users and reported to the manufacturer.

- Boldness: it is the extent to which the system is reasonably involved in unexpected situations, not covered by the specifications
- Efficiency: A system is efficient if it uses memory, CPU and other resources in a way proportionate to the services it performs, that is without waste.
- Usability: A system is easy to use if a human being considers it as such. It is subjective quality that depends on the context and experience. However, there are shared principles that allow us to assess the level of usability of an application, regardless of subjective factors (ISO 9241-10 "Ergonomic requirements for office work with visual display terminals").

The internal parameters refer to the quality of the software as perceived by the developers and include:

- Verifiability: A system is verifiable if its correctness and reliability properties are easy to verify.
- Maintainability: Easy to make changes to the realized system. Not only related to bug fixing, but any modification is required.
- Reusability: Possibility of using parts of the system to create a different product: specifications, projects, testing.
- Legibility: SW code is readable when favors its verifiability, maintainability and reusability.
- Modularity: Property of a system to be structured in components that operate in that system regardless of operations of other components.

3 TURNKEY OR FIXED PRICE PROJECTS

The term turnkey project (turnkey delivery) describes the contract method for a project (or delivery of such) in which the supplier is liable to the customer for the entire project result and presents the product to the customer / service finished and ready to be used. The customer should only be able to "turn the key", a metaphor for immediate access to the product / service. The turnkey project contract is also called turnkey solution, turnkey delivery or fixed price (turnkey solution, turnkey delivery, fixed-price contract).

Deliveries in the form of turnkey projects are now making headway in IT (turnkey implementation of information systems), while they have long been used in civil engineering and construction projects.

In a turnkey project, the supplier assumes full responsibility above all for respecting delivery dates. The customer, therefore, being not affected by any risk, does not interfere during the activities of carrying out the project. The activities estimated in the contract involve different macro phases, such as Requirements collection, Organization of the Work (Schedule and Cost), Development and Testing, Monitoring, Delivery.

This chapter explains the elements of Project Management that are decisive in a Turnkey project.

Requirements collection, Work Breakdown Structure, Project Effort and Milestones are terms we often hear about in Project Management. This chapter explains their meaning and underlines their importance for the success of a turnkey project.

3.1 DIFFERENCES BETWEEN T&M AND TURNKEY PROJECTS

For the realization of a highly customized IT project, quantifying the overall effort and draw up an "all inclusive" offer is always difficult for the supplier. The variables are the quality expected by the customer and training activities,

data reporting and extra effort hours due to unforeseen events. The habit of stipulating an open consultancy contract, called Time & Material, became widespread, in which the supplier (typically an ICT company or a consulting company) makes a rough estimate of the working days provided for each activity by identifying the hourly cost of his resources (Time). The same thing happens for the *Materials*, determining a fixed rate for each unit and category of material (typically cost of man-days for a given activity).

At the end of a specific agreed period, the supplier (consulting company or ICT) invoices the project by sending the customer a detailed calculation of the activities and hours worked by the team. When the resources are directly engaged in the customer's premises, the customer can have immediate feedback on the actual commitment required by the project.

The feature of Time & Material contracts is having the team available for the time necessary to achieve the set results. This seems to be a positive aspect, which translates into a negative aspect when there is no fixed cost to be attributed to the project in advance. As a solution, however, the client company can request the insertion of a limit of hours not to be exceeded in order not to end up spending too far from the initial estimate.

The fixed-cost contract is instead called Turnkey. In this case, starting from the collection of customer’s requirements, then translating them into technical requirements (or simply tasks to be implemented), the supplier estimates the overall project effort. The risk is assumed entirely by the supplier company, while the client company occupies a privileged position by taking advantage of a fixed price and agreed ex ante for the entire project.

In this sense, it is possible to evaluate the stipulation of a "mixed consultancy", in which the most easily estimated elements of the project have closed costs, while those that are more uncertain (such as training or future implementations regarding new requirements) are open.

In the following paragraph the critical elements of a Turnkey project are analyzed, explaining how from the correct scheduling of the single tasks a total effort estimate of the project is obtained.

3.2 REQUIREMENTS ENGINEERING

In an increasingly global and competitive market, responding to consumer demand means understanding the needs of the customer very quickly and at competitive costs. Understanding the customer's needs is not a trivial matter, it is about the success of the product or project intended for the end user.

In this regard, it is essential to structure an approach that supports companies in understanding the *customer requirements* and in making the product requirements simpler and more explicit. The activity of *customer requirement* collection and management is called *Requirements Engineering*.

The creation of a method that supports the analysis of the requirements could be a tool aimed at responding to the market challenges mentioned above.

The Pre-Sale phase, aimed at understanding the client's *pains* and proposing a valid solution to overcome these problems (*gain*), must exploit tools capable of bringing out all the needs. It is important to satisfy even the most implicit ones, through a communication and a well-guided exchange and that avoids any form of ambiguity or uncertainty.

Obtaining a good collection of the requisites is essential to the following product or project development phases.

For these reasons the analysis and collection of the requirements has been the subject of studies and academic researches. Being able to find and adopt univocal methods that can be used in any market and with any customer is very difficult, moreover the collection of the requirements of a software product often involves having to face the not-competence and unawareness of the customer in IT field.

Steve Mc Connell, expert of Software Engineering and Project Management, in his book writes: *"Repairing a defect in the requirements that remains hidden until the implementation or maintenance phase of the system will cost 50 to 200 times as much, if compared to what would have been spent if the defect had been detected during the collection of the requirements"* .

The quotation explains the strong importance of the requirements collection phase from an economic point of view, attributable to both Waterfall projects and Agile projects.

Regardless of the project approach, in Turnkey contracts in general the economic risk is charged to the supplier company. To be immediately in empathy with the customer and to deliver a product appreciated according to the deadline, it is essential to carry out this phase meticulously. The Requirements Engineering involves requirements management, analysis of the context for which these requirements are collected, analysis of a language that allows to document the collected requirements.

It is good to define what a requirement is and specify the types of possible requirements.

3.2.1 Definition

The main subject of Requirement Engineering is the requirement collection.

As stated in IEEE Standard Glossary of Software, the requirement can be defined as:

1. A condition or ability necessary for the user to solve a problem or achieve a goal;
2. A condition or capacity that must be met or owned by a system or a system component to satisfy a contract, a standard, a specification or other formally imposed documents;
3. A documented representation of a condition or capacity in 1 and 2.

It is possible to distinguish between User Requirements and System Requirements.

The User or Customer Requirements are the requirements that emerge from the interaction with the stakeholders. Stakeholders do not always come from technical areas, so these requirements are expressed in simple language and general provide information, to analysts and technical managers, about the needs and expectations of the client. Furthermore, they provide a description of the activities that end users expect to carry out with this product and practices they wish to do using the software. From these requirements it must also extrapolate the customer's unexpressed or implicit needs.

3.2.2 System (Technical) Requirements

System Requirements are the building blocks that developers use to build the system. These are the traditional *must statements* that describe what the system should do. System requirements are classified as both functional and supplementary requirements. Being intended for specialists, the technical aspects take shape in the system requirements, as more detailed versions of the user requirements. System requirements should describe the external behavior and operational constraints, using more detailed notations than those used for user requirements.

3.2.3 Functional Requirements

Functional Requirements are those requirements that explain how the system should behave following certain events or in response to certain inputs. They describe the behaviors in form of use case from the perspective of the end user. The functional requirements serve to define a description of the service that the software system (or any other product) must provide, based on the inputs it receives and the outputs that must provide. Through this type of requirements, it is possible to define all the cases in which a certain functionality can be requested under certain conditions.

The requirements that define the data, the functions and the behavior of the system are, in most cases, solution-oriented requirements since they are defined in a way that mainly supports the realization of the system.

3.2.4 Quality Requirements

Quality Requirements means the definition of the characteristics that measure the quality of the system and that must be developed in terms of performance, reliability or stability. What these requirements are and their impact on the system are discussed in the Quality Assurance paragraph above 2.2.1.

3.3 WBS

A project needs to be analyzed in all its individual phases. Many complex projects involve the execution of several activities that, without proper planning and organization, would be difficult to carry out.

To try to make all the phases of a project more comprehensible, the WBS (Work Breakdown Structure) is used, also defined as *Structured Breakdown* of the project: it is a methodology developed in the United States, useful for structuring and defining clearly all the activities of a project.

In a turnkey project, optimal organization and breakdown of work and resources is essential to estimate the project effort as accurately as possible, and therefore a fixed price for the Customer.

3.3.1 Definition

The WBS is a tool used for the analytical decomposition of a project into elementary parts. From the PM book, the definition *is "A deliverables-oriented group of project elements that organizes and defines the total work-scope. Each descending level represents an increasing detailed definition of the project work."*.

The aim is to organize the work into more easily manageable elements and to make the understanding of the project less complex, to communicate to all the

subjects involved (stakeholders) the phases and activities to be carried out in order to achieve an objective. The WBS provides a valuable aid to the project manager especially in the definition and organization of complex project activities.

The WBS, in general, can be applied to any type of project, both in the building and civil sectors, and in the IT area for the realization of complex customizations.

As generally as possible, Harold Kerzner (world-recognized guru in Project Management) defined hierarchical principles that have proven to be effective for IT projects.

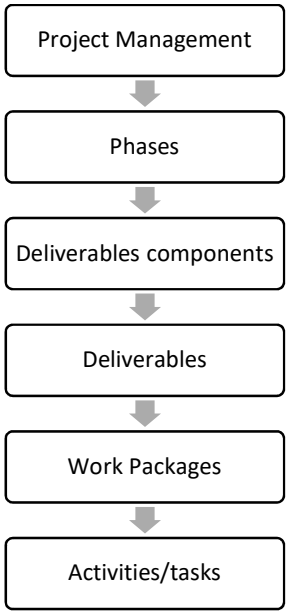

Figure 7- WBS hierarchy

First, specify and break down the deliverables into valuable and measurable work packages. Second, assign major activities to each of the work packages. Finally, allocate effort, costs and schedule to each of the work packages based on an allocation scheme to estimate the value of each deliverable.

In this paragraph the decomposition of activities and the allocation of resources are explained. The allocation of costs and effort estimation will be explained in the next paragraphs.

3.3.2 Decomposition of activities

With the WBS tool the project is divided hierarchically into components (for example sub-objectives, specific activities and tasks), with an ever-increasing degree of detail, following a top-down approach. The WBS divides and subdivides a project into different components, whether by area, phase, function, or other considerations. Each level represents more and more detailed portions of the project.

The highest level in the WBS consists of a single element, the project. At the next level, there may be only a few elements or items. The further going down in the WBS, the greater the granularity of decomposition and the amount of detail. The level of detail can be determined by the scheduling needs and the roles chosen.

There is no defined number of levels: the decomposition depends on the complexity of the project and ends when the last hierarchical level has a degree of detail such as:

- describe univocally the individual job to be performed;
- allow the attribution of executive responsibility.

On the Project Manager side, which is a single figure in Amarìs both for the Agile development team and for other Waterfall work teams, the breakdown of activities takes this form (Figure 8 - Decomposition of activities). The different waves are similar to the subsequent sprints released. Each wave can be further decomposed in phases, and each phase consists in the implementation of some tasks. The project manager is therefore still tied to a top-down approach with waterfall shape. The organization of the implementation instead takes place according to some Agile frameworks.

This type of vision has been taken into consideration for the creation of the PM support tool.

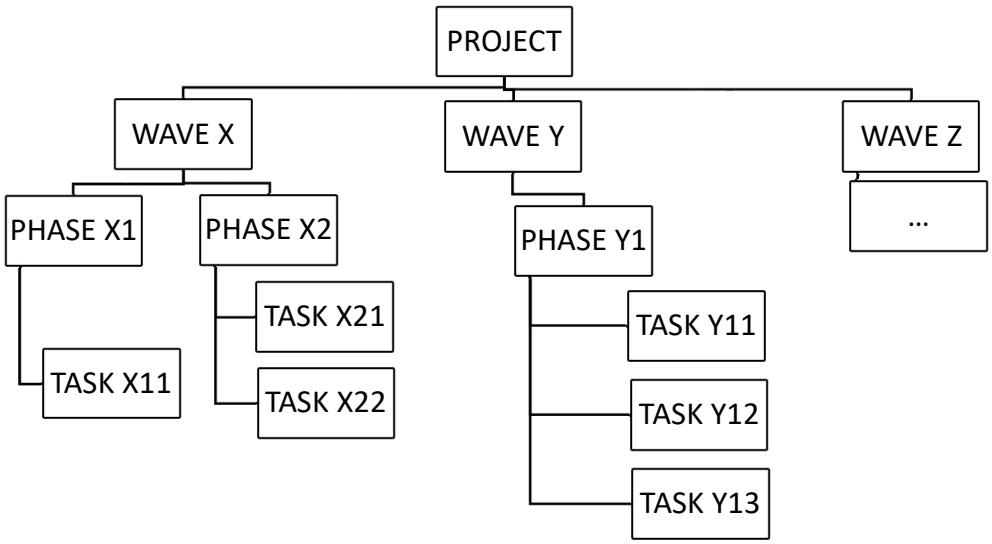

Figure 8 - Decomposition of activities

3.3.3 Organizational Breakdown Structure OBS

The Organizational Breakdown Structure is a document that the company uses, with the WBS, to organize the resources that will work on the project. With the OBS the details of the hierarchy and the structure of the reports are indicated in a formal way (who should refer to whom).

1. DESIGN. The OBS is usually represented using charts or diagrams. Under the declared PM, different divisions are created (product development, design, materials management and production). Under these divisions there may be several sub-categories or names of employees listed directly in the larger divisions. The OBS design is like a tree: each branch indicates a working relationship and side communication responsibility. The closer to the top of the OBS a person is, the more likely that person will have wider responsibilities.
2. RESPONSIBILITY. OBS utility depends on an optimal WBS, as already mentioned. The WBS describes in detail what each person listed in the

OBS should do to achieve the goals of the project. Ideally, people are assigned to tasks that match their interests and strengths. This promotes a sense of belonging to the project and presupposes that people take responsibility for the development and completion of their tasks. In smaller organizations/companies, project members may be called to fill multiple roles.

3. BUDGETING. A division of resources is a list of monetary, physical (equipment) and labor force funds needed to complete a project. Proceeding with a top-down approach means to indicate where resources must be channeled; alternatively, proceedings with a bottom-up approach, means questioning team members, after task assignment, to ask them what they need to complete it successfully. This last approach could be ideal if there are no strong budget constraints: budget and resource management is in the hands of those who actually use the materials.

3.4 EFFORT

The effort is the number of *work units* required to complete an activity. This is usually expressed in hours, days or weeks worked. For the reasoning of this thesis, reference will always be made to man-days as a unit of work.

The effort is therefore the number of man-days required to complete an activity. In order to estimate the duration of a project, the effort must first be determined.

Project management deals with concepts that are apparently similar but that hide substantial differences, such as *effort* and *duration*.

For example, if two resources will need three days to complete a given activity, what does it mean? Is it about the time amount before the work completion or the total man-days that the work will need? Thus, effort means the man-days that a person would take to complete an activity: suppose six man-days. If this work is done by two people, approximately the work will last 6/2 = 3 days and

therefore this is the duration of the work (supposing that the two resources are allocated at their maximum to such activity). The duration, of course, represents the man-hours divided among the available resources, according to an accurate scheduling, WBS and OBS; it is approximate because the pace of work, experience and productivity of people are not always the same.

Everything starts then from the estimate of the effort. In the discussion of Project Planning (5.1), estimation techniques will be explained. It is easy to understand, however, that a correct estimate of the effort depends on a correct analysis of the customer and technical requirements and on a correct breakdown of the work, reducing the activities to the minimum terms (tasks).

In turnkey projects where, as mentioned above, the price is fixed, there is no error margin in the estimates. It is necessary to have great experience in the field to evaluate the effort needed to perform a task, especially in relation to the technology and the means used to carry it out.

3.4.1 Estimation – Guidelines

Understanding the difference between effort and duration of an activity is therefore fundamental for the correct planning of a project. As stated, everything starts from the estimate of the effort.

There are some tips for a better estimation:

- Estimating is an activity that is always *on going* and should take place regularly during the project. The initial estimate will thus be increasingly deepened and gradually perfected.
- During the start-up phase of a project, being sure the team agree on what needs to be delivered and then estimated. Team means project manager and project team in the first place, but also managers and all project stakeholders.
- Involving the experts in the analysis and estimation process and brainstorming with the people who will have to do the work. It is useful

to have different groups of people who value the same thing. If comparing the results there is a large disparity between the numbers, it means that the uncertainty about the activity, or the project in general, is high.

- All estimates carry an intrinsic degree of uncertainty, especially in the early stages of the project in which there are more unknowns. It is essential to quantify the percentage of unknowns in the estimate and compensate with an equivalent level of contingency.
- Always considering the risks and contingencies of the project, never considering only the best hypothesis.
- Considering all the phases and activities of the project, including analysis, design, planning, implementation, possible reworking, delivery, project closedown.
- Estimating the effort in points or hours of work compared to calendar time to cope with the fact that the team is never 100% effective. There are separate conversion factors to translate the estimated time in calendar time. This will make it easier to track the accuracy of the estimates.
- Recording the estimates formally and document how they were found, through which information and which processes.
- Research and experimentation with different estimation tools and techniques. The estimation tools will help to consider all the different aspects of the project and will automatically add further contingency. Later main tools and techniques will be listed and explained.

3.4.1.1 Estimation Approaches

The estimation approaches and strategies can be divided into two broad categories:

1. Bottom-up or analytical estimation method;
2. Top-down or strategic estimation method.

The two estimation techniques can be applied alternatively (depending on the information available) or in combination in order to carry out a cross-check in order to arrive at appropriately company evaluations.

The bottom-up approach plans to start from the elementary activities that arise from the WBS analysis and to estimate the duration, resources and cost for each. Subsequently these costs are aggregated for each component of the WBS in order to obtain the total values. Among the estimation techniques, the bottom-up technique requires detailed knowledge on how the work should be developed and therefore can be conducted with the project team.

The advantages of the bottom-up method are:

- maximum accuracy as all the details of the project are taken into consideration;
- reliability on elements on which there is direct knowledge by the project team;
- it allows to balance the opinions of the different people that make up the team.

While its disadvantages are:

- it takes time to evaluate every detail;
- it is not very accurate in the initial phases of a project when the available information is still limited;
- some evaluation errors can reverberate throughout the WBS;
- the estimates may not be stable over time.

On the other hand, the top-down approach is one of the most widely used estimation techniques in the initial phases of a project when there is still not enough detailed information. Starting from the high-level components of the WBS, it evaluates them by analogy with respect to previous projects or based on parametric estimates or based on the opinion of experts or the internally agreed budget. These modes will be explained later.

After having carried out this first level of estimation, the values obtained are spread on the lower level components up to the individual activities that make up the project and derive from the analysis of each work package.

The advantages of the top down method are:

- the estimates are rapid and do not require detailed information;
- it allows to understand the evaluations that the top management or the commercial structure have made during the project start-up phase.

Its disadvantages are:

- the method is not very accurate and reliable;
- the estimates will have to be verified when more detailed information will be available;
- it can lead to conflicts with the resources that the work will have to perform if the values obtained are not realistic.

	ADVANTAGES	*DISADVANTAGES*
BOTTOM - UP	Maximum accuracy (detailed)	Accuracy takes a lot of time
	Reliability on team capability	Initial lack of information
	Team agreement balanced	It brings errors to WBS
		Estimation not stable over time
TOP - DOWN	Rapid Estimation	Not very accurate and reliable
	Consistency with the top management evaluation	Further verification with further information
		It can lead to conflict between resources

Table 1 - Summary of Estimation Approaches

3.4.1.2 Estimation Methods

Regardless of the type of approach chosen, the following methods can be applied, individually or in combination with each other:

- Estimates by analogy, which compares the project with similar projects already completed;
- Parametric estimates, based on the metrics used in past estimation process;
- Expert opinion, which requires involving people outside the project team;
- PERT estimate, which considers three values for each estimate: an optimistic value, a pessimistic one, a probable one.

In IT projects, the most appropriate approach is a bottom-up, mainly using the analogy method. When the experience in the field and in the technology is high and the type of projects in charge is very specific, this method is the most effective. It is applicable both to the overall system and to individual

components of the WBS. The estimation techniques by analogy is used for rough assessments in the preliminary stages of the start of a project, useful also as a comparison.

The necessary steps are:

- Understand the characteristics and scope of the project;
- Select the project that is most similar to those for which historical data is available;
- Highlight the differences between current project and previous projects;
- Prepare the estimation process.

This method is fast and based on real data, so it can also be accurate if multiple projects of the same type carried out previously are taken into account.

However, it is bound by the quantity and quality of historical information available and it is inaccurate if the projects are too different. To apply it, professional experience is required, which can involve the presence of expensive resources (internal or external).

To have a better level of accuracy it is applied in combination with the parametric estimation technique. The main parameter used by the project manager is the man-days measurement unit. The estimation of a component can derive from analogous components of the current project or of previous projects simply considering the unit values of the parameters in question and then multiplying them by the units necessary for the completion of each activity or work package. This method is successfully implemented by the team. The only negative is that past errors can propagate on current and future projects, but this is however related to a possible poor project monitoring activity and absence of corrective actions.

3.5 MILESTONES

As for the effort, also to define a milestone it is necessary to underline the differences with other similar terms often misused. Defining the main stages, phases and milestones is an essential part of this paragraph.

- Stages: groupings of project activities and each grouping has important implications from the point of view of control by the Project Control Committee. At the end of each stage, a *major review* is planned by the Control Board to verify whether to continue or interrupt the project.
- Steps: phases of a project's life cycle. They are therefore groupings of different activities based on divisions between the types of work. For example, there may be a feasibility analysis phase, a design phase, a prototyping phase, a test phase, a pilot phase, a phase of full realization, a maintenance phase.
- Milestones: control or delivery points, at the micro-scheduling level. They are often considered normally activities (conventionally with zero duration) that isolate the main moments of delivery verification in the schedule. They may coincide with presentation meetings, signature of acceptance reports, even telephone calls for confirmation of an agreement. In fact, each of these circumstances serves to approve what was done upstream of the milestone and enable the activities planned downstream of the milestone.

Phases and milestones are the main blocks of activities necessary to achieve the objectives of the project and the key hubs of a project. The number of stages, phases and milestones of a project necessarily depends on the scope and complexity of a project. Structuring the plan by stages and milestones can help reduce control points by grouping them into more easily controllable blocks.

3.5.1 Features

A milestone coincides with the achievement of project objectives. There are characteristics to define a milestone that is more implementable and effective. Milestone is a project goal. It is advisable that goals are defined with the following code (SMART).

- Specific. Each milestone must be specific in its purpose. Milestones that are not specific are vague, confusing and subject to being canceled. Therefore, each milestone must clearly imply specific actions by the parties involved.
- Measurable. The achievement of a milestone must be measurable and verifiable in terms of time and content. This can be done with checklists aimed at highlighting which and how many of the activities upstream of the milestone have been completed and how many still not.
- Achievable. The milestone should be actually reachable. The key is to introduce milestones that are within the ability of the project team and that involve actions of core standards and practices.
- Relevant. It may be obvious that a milestone involves the achievement of a significant result. If too many aspects are involved outside the scope of the project this can derail the project or produce a drop in the commitment.
- Time Bound and Trackable. Like any other project objective, a milestone must be traceable in terms of time. If a milestone is not associated with a specific deadline, the team will have an inevitable tendency to procrastination.
- Assignable. A milestone must be characterized by a specific set of actions so that it can be assigned to a manager who will take care of its implementation or verify its completion. If the responsibilities are too widespread and not clearly defined, the result will be a poor oversight of the actual achievement of the expected results.

- Progressive. The milestones of a project should follow a linear path of progression. This means that, by completing a milestone, conditions should be created to complete the next one. Inserting milestones at the end of the project that depend on those placed at the beginning, can lead to a useless waste of time. Once a milestone is complete, it should be 100% finished and the next should be 100% feasible.

3.5.2 Misconception

The milestones' concept is different from the estimates of duration and effort. Sometimes the reach of a milestones is considered as the status of project progress. If a milestone is quickly reached, it does not mean that getting to the next one will not take a lot of time, ending the project in delay.

Moreover, milestones are an estimation of their occurrence date. Often the estimate is used as a goal, losing of the possibility of obtaining improvements in the project and of reaching that milestone earlier.

In project management, the coordinator (project manager) tends to use milestones as tools for team involvement and stimulation. The Project manager tends to verify on the scheduled date the achievement of the single Milestone, omitting to examine the project in a wider perspective.

4 PROJECT MANAGEMENT

To define Project Management, it is possible to use keywords and concepts that give a practical idea of what it is.

First of all, Project Management is forma mentis, method, mental organization and work planning, but also proactivity, relational skills, knowledge of the context in which the project is coordinated and of the people involved, negotiation, listening, resource management. It is not rigidity, it is not mere technicality, it is not just the use of tools.

Being a recent phenomenon, it is a common belief that Project Management is useful only in certain contexts, and that it is not very applicable, for example, to more routine activities or staff functions. Actually, in modern organizations, no unit can afford to work with infinite resources, but instead it is essential to seek maximum effectiveness through an optimized management of its own resources (people, skills, assets, tools, know-how in general). Even just by using some fundamentals of Project Management it is possible to achieve better individual and team results, a greater level of awareness and control with respect to all the variables that influence the achievement of the same objectives and a less artisanal and improvised team management.

In a nutshell Project Management is an approach that helps to manage complexity, referring to both structured business projects and the daily operation of any activity.

According to the PMI (Project Management Institute), the term Project Management refers to the management of all the business activities both front and back office. In other words, Project Management must be understood as the ability to follow a given project in all its evolutionary phases in compliance with precise constraints assigned by the client, both external and internal. The constraints that must be respected are usually linked to time, costs, allocated resources, objectives and quality of the finished product. The PMI defines

project management as the application of knowledge, attitudes, tools and techniques to the activities of a project in order to achieve its objectives.

There are two processes in the project management activity that it is important to analyze in this study on the Earned Value Analysis: Project Planning and Project Monitoring. The description of these two processes in this chapter is necessary to understand both the need for a customized support tool and their importance in turnkey projects.

4.1 PROJECT PLANNING

Project Planning is a disciplined process that establishes a plan to coordinate and direct resources, such as time, budget and skilled people, to achieve the objectives defined by the business management. The purpose of Project Planning is to establish an adequate project plan for simplified project delivery and management. In this process the project manager makes estimates development, assignment of commitments and definition of the work plan.

The project plan is placed in the first planning phase and constitutes the fundamental moment in which the project takes shape. Essentially it is an official document, subject to approvals, which describes the project objectives and the elements necessary for achieving them. This document is integrated with the Project Charter and must be consistent with it.

4.1.1 Activities and budget planning in Agile

The project plan for a turnkey project consists in the detailed planning of the key elements described in chapter 5: identification of technical and functional requirements, definition of WBS and OBS, effort estimate for previously broken-down activities and milestones setting. Note that the CBS (Cost Breakdown Structure) is not mentioned because in IT consulting the project manager is efficient in man-days and the overall budget is given in terms of total man-days. The cost of a man-day varies based on the experience of the consultant and often these financial aspects remain confidential and not

disclosed to the project manager. This approach is only possible in turnkey projects and therefore at a fixed price. The effort estimates are made on the basis of the available resources that will work on the project, whether senior or junior: the abilities and past performance of the available resources are taken into account and the offer to the customer is made on the basis of an average cost of consultants.

Agile planning proceeds step by step and iteratively. This, however, in the reality of the consulting world must be in compliance with specific deadlines. Also, it must follow the duty to report to the steering committee how it will proceed and afterwards, the progress of the work.

In Agile, with a hybrid approach, the project manager together with the team breaks down the activities into tasks according to the rules already discussed. Assign tasks to resources considering the effort to be supported also on other projects already in progress. The Agile team then defines how to proceed for Sprint (continuous release of functional versions of the software). The Sprint Planning provides for a greater level of detail and a division into tasks. The result of the Sprint Planning is the Sprint Backlog (the list of activities that the team is committed to complete by the end of the Sprint). The prerequisite for good planning is to have a Product Backlog prioritized correctly by the Product Owner (customer) who actively participates and interacts with the team even during implementation.

Actually, the fact that an item is in Backlog does not mean that it will certainly be addressed, developed and released. However, this does not go well with the concept of delivery in fixed price projects. In the reality of Amarìs Torino it must be considered the type of contract adopted in consultancy: turnkey contract. The first meeting therefore takes place between Product Owner and Project Manager. The latter presents his skilled consultants to be proposed for the project and the requirements are collected. On the basis of a correct estimate of timing, a formal commercial offer is prepared.

From the moment in which this offer is formally accepted by the Customer, the planning activity begins. This activity also considers other projects that the team has in charge, and therefore how much time can actually be dedicated to the new customer. In planning for simplicity, the milestones coincide with the scheduled Sprint Release. Everything that has been declared in the contract in terms of user requirements transformed into technical requirements to be included in the Backlog must necessarily be implemented, as the customer pays and issues invoices during the project to obtain certain features in subsequent releases. Also, in this issue it is not possible to ignore a certain degree of formality and to follow purely agile practices in IT consultancy.

There are three factors that influence the Final Result of the Project:

- A solid Project Baseline, therefore, a realistic forecast of the result;
- Actual Status of the project, monitored through project progress indicators;
- Corrective Actions, which critically influence the final result.

The next chapter focuses on the second factor, Actual Status of the project.

4.2 EARNED VALUE ANALYSIS

The evaluation of the progress is crucial in order to monitor and control a project. Monitoring and control are two distinct activities: monitoring consists of collecting actual data regarding the progress of the project and annexes. Having the project in control means being able to manipulate the monitored information and the project variables, to bring the progress according to the desired way. The time spent or costs recorded in the final balance by the planner do not necessarily indicate the status of the work actually carried out, the so-called *physical progress*. The amount of time and cost spent on the project are to be kept separate, as an activity may have exhausted its budget despite having implemented half of the expected output. This would mean monitoring the project but not being able to control it. Criteria must be

established to be able to measure the progress of each activity and consequently of the entire project.

In Project Management often the analysis of the performance of a project is based on two fundamental variables: Time and Costs. This analysis is called *Milestone Analysis*[8], when a milestone is used as a precisely scope of work. This allows to view the deviations from what was scheduled and budgeted only at the time of milestone achievement.

This project monitoring method is a "waterfall" method, in the sense that assessments are made only downstream, not upstream or during the course of the project. This does not allow to detect problems or errors until the delivery has been made.

It is clear that this type of approach is obsolete, yet it is still widely used. It is also clear that it does not go hand in hand with an Agile implementation, as each milestone corresponds to a sprint, and therefore to a release with additional features: because of Agile's vaunted flexibility, it is necessary that a set of tasks are carried out simultaneously at a certain pace of work and consistently. Thus, the amount of work performed periodically must be monitored.

Finally, it is clear that the Milestone Analysis does not match even with a type of turnkey contract, as the risk in managing time and resources (and therefore translates into costs) is high and requires a level of accuracy not only in planning, but also in respecting the plans. It is not affordable to do an *ex-post* evaluation / monitoring and find that the project is at a loss or late (the two do not always coincide).

The Earned Value Analysis (*EVA*) integrates Time, Cost but also Work Performed, in man-days or by ascribing monetary values to each. This analysis is used as a project monitoring technique during all its phases and therefore

[8] From l

periodically. The Earned Value quantitatively measures the progress status of the project.

The true credibility and possibly the value of the EVA are rooted in the integration of project scope, schedule and cost. The WBS (as described in Figure 8) is the vehicle for the integration of all the work elements according to the hierarchical tree. By measuring the single current performance and predicting the future one, the aggregation of the tasks (o work elements) following the hierarchy of the WBS guarantees to determine the current performance and predict the future one of the entire projects. This integrated and consistent way of measuring and predicting creates a vital improvement in project management compared with the separate analysis of the schedule performance and the cost performance charts: the separate analysis give rise to non-integrated and often conflicting, performance measures.

The project manager who enters the perspective of using EV analysis achieves a number of important goals including:

- Understanding exactly where his project is;
- Having control over the costs and the estimates to end;
- Being able to justify any of its claims on the state of project;
- Being able to make predictions;
- Taking corrective actions based on forecasts, knowing how to measure them.

The assessment and efficiency of different projects are comparable, consistent and the data are presented with transparent information. This would not be possible if the information came from different measurement systems, perhaps differentiated for large projects or smaller projects. EVA is therefore a universal system that allows the comparison between projects of a different nature and facilitates the project manager in the management of resources and customer relations.

To carry out the Earned Value Analysis it is necessary to formulate a Control Account Plan (*CAP*). The CAP is the basic building block of the EVA: thought CAP it is possible to identify at which hierarchical level of the WBS the measurements are made, the type of unit of measurement, the method of measurement and the frequency. Concerning the type of unit of measurement for the work performed, there are several options and the most important ones are listed in the table below.

Type of the Method	When to use	Major Advantage	Major Disadvantage
% work complete	Well-defined work packages; management reviews in place	The easiest method to administer	Made purely on the subjective basis
Fixed formula	Work packages are detailed; nonrecurring tasks	Easy to understand	Rather subjective
Weighted milestones	Work packages run two or more performance periods; non-recurring tasks	The most objective method	Difficult to plan and administer
Earned Standards	Preestablished standards of performance; nonrecurring tasks	Most sophisticated of all methods	Requires the most discipline

Table 2 - Fundamentals of EV measurement methods

For the frameworks that characterize the work in the Amaris company, the *percent complete* method was chosen. Through this method, the project manager questions the consultants involved in the project on the percentage of completion of a work package, usually of a task. This percentage is a cumulative value of

the work done so far compared to 100%, which corresponds to the completed work package.

4.2.1 Indicators

EVA measures project performance through the pillars of the method. First of all, the basic measurement indicators are defined and expressed in man-days as unit of measure.

1. BAC: Budget At Completion is the original total budget that the client is willing to pay for the project. The project is divided into different tasks to be implemented. Each task is estimated by an effort in man-days. The sum of the effort of tasks determines the effort in man-days of the project, so the BAC. It is called also Budgeted Cost of Work Scheduled, since it represents the value of the Planned Work expressed in terms of Budget.
2. PV: Planned Value represents what is planned to be spent within a given date, based on the tasks' scheduling. It is required to prepare a list of planned date and for each date it is required to plan the value of man-days spent for each task at that date. The basic prerequisite is that all work must be planned in comparable increments.
3. AC: Actual Cost is how much has been spent (in man-days) at a given date. In order to compare AC with PV (planned value), the Actual Cost must be inspected on the same planned dates set for the planned values check. The spent value (AC) does not give a measure of how much work has been produced in the time frame.
4. P%: Produced indicates in percentage how much work has been completed within the planned date of the check. It is tracked the percentage of work progress of the single task.
5. EV: Earned Value is computed as

   $$EV = BAC * P\%$$

   in order to estimate how much of the total budget has been accomplished in terms of budget cost (in man-days) of work performed at the planned

date of the analysis. It is also called Budget Cost Work Performed (BCWP) since it represents the value of the work produced, expressed in terms of budget.

6. EAC: Estimate At Completion is an estimation at the planned date of monitoring of how much the total cost of the project will be at the end. It is the projected budget at the end of the project and is computed as

$$EAC = \frac{AC}{P\%}$$

which is the same of $EAC = \frac{AC}{EV} * BAC$.

7. ETC: Estimate To Completion is an estimation of how much of the budget is needed to complete the project. It is monitored during the lifecycle of the project on the plan dates as

$$ETC = EAC - AC$$

8. The Cost Performance Index (CPI) and the Cost Variance (CV) give a comparison of the amount of work performed during a given period with what was scheduled to be performed.

$$CPI = \frac{EV}{AC}$$

$$CV = EV - AC$$

If $CPI = 1$, it means that the work progress is perfectly in line with the work schedule ($CV = O$).

If $CPI < 1$ the project is behind the schedule ($CV < 0$).

If $CPI > 1$ the project is going faster than the schedule ($CV > 0$).

9. The Schedule Performance Index (SPI) and the Schedule Variance (SV) give a comparison of the amount of work performed during a given period with what was scheduled to be performed.

$$SPI = \frac{EV}{PV}$$

$$SV = EV - PV$$

If $SPI = 1$, it means that the work progress is perfectly in line with the work schedule ($SV = 0$).

If $SPI < 1$ the project is behind the schedule ($SV < 0$).

If $SPI > 1$ the project is going faster than the schedule ($SV > 0$).

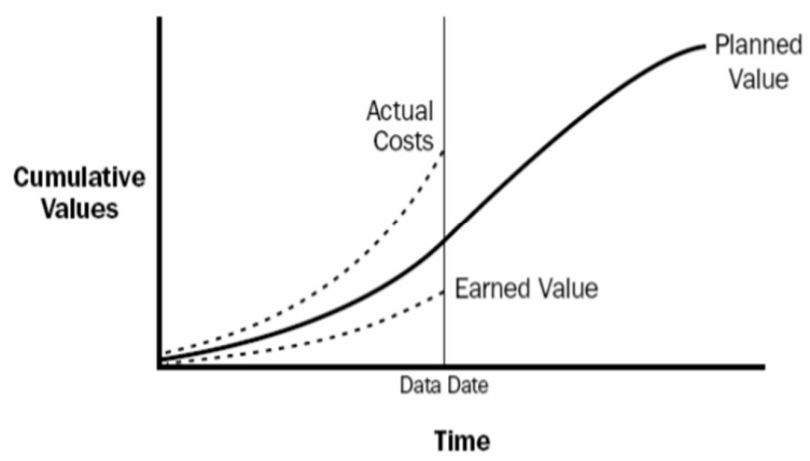

Figure 9 - Basic Costs Lines[9]

The Figure 9 - Basic Costs Lines shows that PV is a value defined prior to project beginning, while AC and EV are measured over time. Beyond the current date of measurement there are not values for AC and EV.

4.2.2 Output

The Project Manager is often called upon to objectively provide information on the project to stakeholders and the steering committee. The steering committee is the highest-level decision-making body in a project. It provides support to overcome organizational problems for which the project manager does not have enough power to intervene. It also supervises the progress of the project to approve the procedures for carrying out the works and the entire delivery process. The essential outputs to be shown during the steering committee meeting are listed below.

[9] From E

First of all, it is interesting to compare the planned value with the actual value (spent value) during the course of the project. If the Spent line lies above the Planned one, taking into account that the values are in man days, the project is late and over budget. On the contrary, when Spent line lies below Planned line, it means that you are gaining time, but this is not always a positive factor as it indicates that the PM is not able to plan in realistic terms. It would be optimal if the two S-curves went hand in hand, with a small margin of difference (spent less than planned). The maximum achievable Earned Value is the total planned value BAC, for this reason in the example below the EV curve joins with the PV curve at the end of the project.

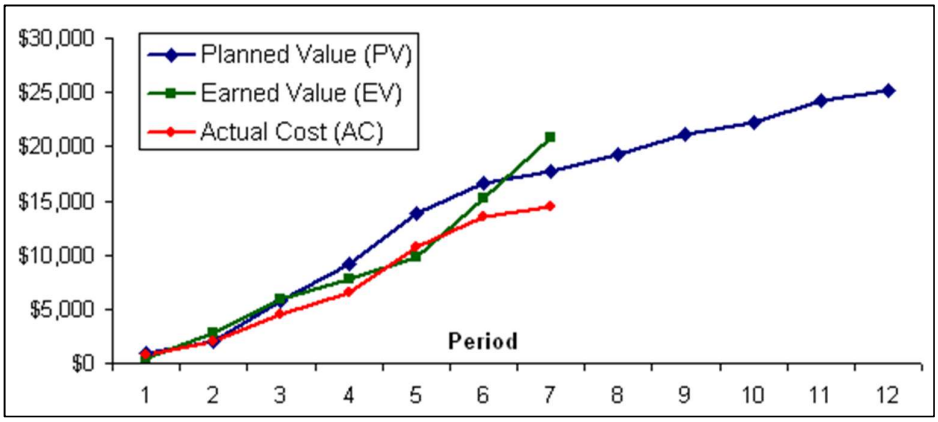

Figure 10 - Planned Value VS Actual Value VS Earned Value example [10]

In this example can be seen that since the first project phase, AC is always less than PV, which is a positive signal.

During the steering committee meetings, it is also advisable to show the values of SPI and CPI, together with those of the respective variances. It would be appropriate for the two curves to follow the same trend here as well, and that

[10] From K

SPI and CPI do not differ too much from the value 1. The comparison between Scheduling and Cost is particularly explanatory on the project dynamics. It can be in line with scheduling and deliveries, but by assigning the task to more consultants than expected, so spending more than expected. It can also be on time but spending less than expected, as for instance the consultants during the 30% of their working hours are working on another turnkey project, increasing the efficiency of a team which is already in line with the time scheduled.

This type of meeting is prepared individually for each project, even if overall evaluations can be made internally on the progress of the entire team working on multiple projects. The project manager therefore periodically questions the consultants during the Work Progress Meetings about the percentage of what has been produced on a project task. The PM must then update his data to derive these cumulative values and give an account to the stakeholders and his direct managers.

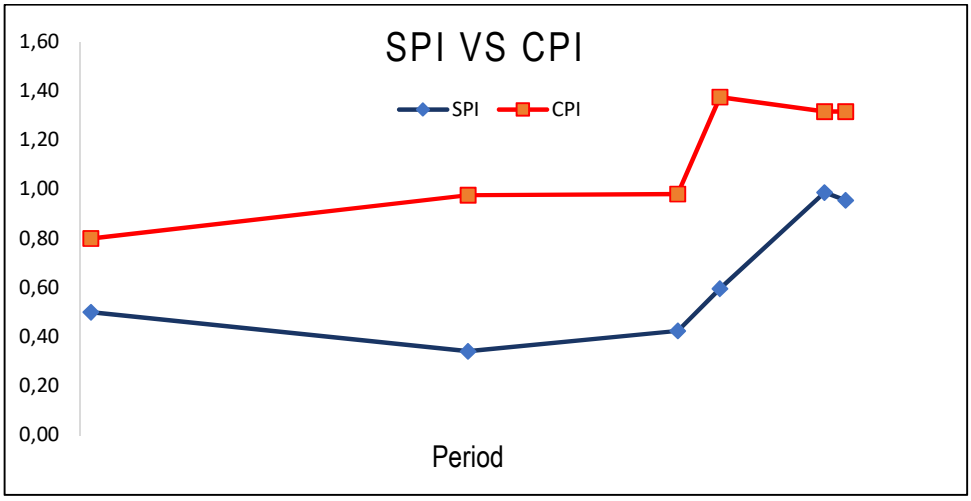

Figure 11 - SPI VS CPI example

Where a value differences too much from 1, it is necessary to be able to understand the real situation, event, role, organization that led to the atypical numeric value, both in positive and negative sense.

5 DATA PROCESSING AND PROJECT MONITORING TOOL

The chapter analyzes the type and functioning of the tool most used on the market for project monitoring support, with the aim of identifying the weak points, which make it poorly suited to the project management activities of the company being studied.

5.1 ANALYSIS *AS IS*

The Project Manager in Amarìs, which deals with projects with delivery contract developed remotely, coordinates two teams: SAP consultancy team (with an approach to waterfall work) and web / mobile services and microservices consultancy team (with an Agile approach to work). Each team is responsible for several projects at the same time, which makes the optimal allocation of resources and the reallocation based on the progress rate of the work of each project fundamental.

The tool used for project scheduling is *MS Project 2016*. This software program allows you to manually enter a list of tasks, a duration for each task, to create a schedule, to record the resources involved and their relative cost, to link the resources to the task they perform. MS Project also has internal reporting tools for the Earned Value Analysis, feasible if the progress data of the tasks are entered periodically.

The first insurmountable limitation of this software is that each MS Project file can be associated with one and only one project. The Project Manager must therefore compile and update four-five MS Project files on average, export the data useful for the Earned Value Analysis to Excel and create ad hoc reports for the Steering Committee with the use of Excel (The reporting tools available in MS Project are not effective because they are incomplete and cannot be modified).

The second limit, no less important than the first, concerns the approach to work. The scheduling on MS project is fitting for Waterfall projects, but not for the iterative work and flexibility of Agile frameworks.

From this limitation derives a third one, which is the asymmetry of information. As mentioned above, the Agile development team uses the Jira Kanban dashboard as a project management tool: a Kanban Dashboard for each project and also on Jira there are automatic reporting options. However, the PM needs a single tool as well as a single metric for evaluating the overall work of the teams. The unique metric identified is the Earned Value Analysis, the tool designed as a solution, instead, is a single customized database.

5.2 ANALYSIS *TO BE*

The solution proposed and implemented is a database on *Access*. The database has been populated with data relating to a single project, but it is also functional with multiple inserted projects.

The database creates uniquely relationships between resources, costs and rates of each resource, tasks associated with the resource and progress index of each task. It was implemented following the project management needs and procedures described in the previous chapters. The useful data are extracted with queries and exported to Excel only for the purpose of creating the key graphs, explaining the Earned Value Analysis. The procedure for creating the relational database is described below, with references in explicit images to the project being tested.

With a mere Problem-Solving scope, a simple solution to a complex problem was individuated. The technology used is not the most suitable in terms of technicians (Access is often not considered the best tool for creating databases) and probably not the most efficient one. The tool aims to demonstrate the feasibility of a database as a solution to the problem of project monitoring in the reality of consultancy.

Excel is a spreadsheet program, suitable for static data. To process different data in relation to each other a relational database must be used

- for relational data integrity;
- for process a data in its personal data (afterwards it can be related to others).

A relational database is a collection of data items with predefined relationships between them. These elements are organized as a set of tables with rows and columns. Tables are used to hold information about the objects to be represented in the database. Each column in a table contains a certain data type and a field stores the actual value of an attribute. Rows represent a collection of related values of an object or entity. Each row can be marked with a unique identifier called the *main key*; the rows on different tables can be correlated using foreign keys.

This data can be accessed in many different ways, without reorganizing the database master tables.

5.2.1 Tailor Made Tool

5.2.1.1 Creation of Master Tables in the Relational Database

First, two master tables (primary information tables) were created: T_CONS and T_ROLE. These two tables have been linked in the T_CONS_ROLE table which univocally associates a consultant with a code and a role.

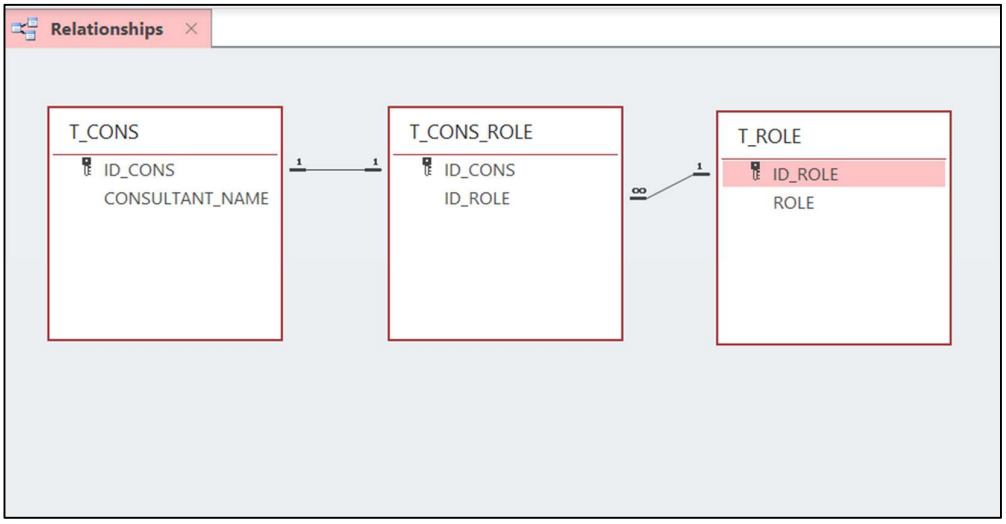

Figure 12 - T_CONS_ROLE Relationship

The referential integrity of the data between uniquely linked key fields is forced with the flag.

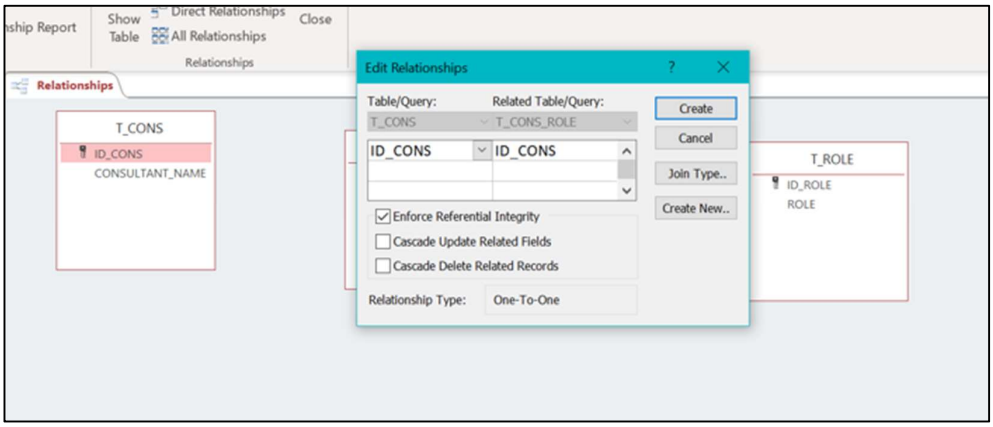

Figure 13 - Editing Relationships

All key fields must be indexed for database efficiency and characterized by a unique key. This system of codes is already used by the PM of the Amarìs delivery, therefore the system immediately proved to be similar to the *modus operandi* used.

Secondly, the project master table was created. In this case, only one project was inserted, with an indexed key field (code) and description.

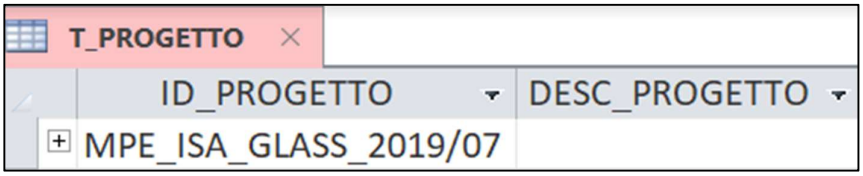

Figure 14 - T_PROGETTO

Based on the resources that work on the project, a price is established. Each resource has a cost for the company but is invoiced to the customer at a different rate from the internal cost. Since the price is established on the basis of man-days, it is therefore established in Amarìs on the average rate of the consultants involved.

A table with this information is then created for the individual project. Real numbers have been entered, but fictitious numbers are shown for the discussion of this thesis. In addition, for simplicity, the same cost and rates have been considered for all consultants:

- Each role (consultant) has a cost for the contractor company;
- Each role (consultant) has a rate (invoicing price) for the client company;
- A master table is created with these information T_ROLE_RATE;
- A related table is derived from T_ROLE_RATE and T_CONS_ROLE.

ID_CONS	NAME_CONS	COST	RATE
ABE	[illegible] Antonio	100	130
DVA	[illegible] Davide	100	130
ENI	[illegible] Enrico	100	130
FNA	[illegible] Francesco	100	130
LFA	[illegible] Loris	100	130
MBA	[illegible] Marika	100	130
MFA	[illegible] Massimiliano	100	130
MIN	[illegible] Marco	100	130
MVC	[illegible] Matteo	100	130
NCA	[illegible] Nicolò	100	130
RRU	[illegible] Roberto	100	130
SDE	[illegible] Simone	100	130
SSC	[illegible] Stefano	100	130
VCA	[illegible] Vera	100	130
VGR	[illegible] Vincenzo	100	130

Figure 15 - T_CONS_RATE

The dates for monitoring the progress of the activities are planned upstream for the monitoring activity. For the Earned Value Analysis, the periodicity of data collection is the necessary element. The PM then defines the dates for the work progress status meeting (SAL meeting - Work Progress Status) and have been entered in T_DATE4PLAN table.

T_DATE4PLAN

ID_PROGETTO	DATA_PLAN
MPE_ISA_GLASS_2019/07	15/07/2019
MPE_ISA_GLASS_2019/07	22/07/2019
MPE_ISA_GLASS_2019/07	09/08/2019
MPE_ISA_GLASS_2019/07	27/08/2019
MPE_ISA_GLASS_2019/07	02/09/2019
MPE_ISA_GLASS_2019/07	09/09/2019
MPE_ISA_GLASS_2019/07	16/09/2019
MPE_ISA_GLASS_2019/07	23/09/2019
MPE_ISA_GLASS_2019/07	30/09/2019

Figure 16 - T_DATE4PLAN

At this point the master table T_TASK_PLAN is created, which consists in reporting the WBS and scheduling in table form. The tasks are those relating only to the first project wave. Each task has as attributes:

- a unique code (indexed key field);
- a start date and an end date (planned dates);
- an estimated effort in man days (planned value).

T_TASK_PLAN

ID_PROGETTO	ID_TASK	START_DATE	END_DATE	EFFORT
MPE_ISA_GLASS_2019/07	GLASS00	15/07/2019	20/09/2019	5
MPE_ISA_GLASS_2019/07	GLASS01	15/07/2019	09/08/2019	20
MPE_ISA_GLASS_2019/07	GLASS02	15/07/2019	19/07/2019	5
MPE_ISA_GLASS_2019/07	GLASS03	26/08/2019	30/08/2019	5
MPE_ISA_GLASS_2019/07	GLASS04	22/07/2019	13/09/2019	15
MPE_ISA_GLASS_2019/07	GLASS04_1	22/07/2019	13/09/2019	15
MPE_ISA_GLASS_2019/07	GLASS05	02/09/2019	06/09/2019	5
MPE_ISA_GLASS_2019/07	GLASS06	09/09/2019	20/09/2019	5
MPE_ISA_GLASS_2019/07	GLASS07	23/09/2019	27/09/2019	5

Figure 17 - T_TASK_PLAN

For each monitoring date, the Actual Values of progress (man-days spent) for each task are entered in the T_TASK_ACTUAL table. To check the Work

Progress Status, T_TASK_ACTUAL table shows which tasks have been closed, which date, and what percentage of each task has been produced. The data are entered manually. Below the records of the table are shown only partially.

T_TASK_ACTUAL

SAL_DATE	ID_PROGETTO	ID_TASK	SPENT	PRODUCED
22/07/2019	MPE_ISA_GLASS_2019/07	GLASS03	0	0,0%
22/07/2019	MPE_ISA_GLASS_2019/07	GLASS05	0	0,0%
22/07/2019	MPE_ISA_GLASS_2019/07	GLASS06	0	0,0%
22/07/2019	MPE_ISA_GLASS_2019/07	GLASS07	0	0,0%
22/07/2019	MPE_ISA_GLASS_2019/07	GLASS01	2	10,0%
09/08/2019	MPE_ISA_GLASS_2019/07	GLASS06	0	0,0%
09/08/2019	MPE_ISA_GLASS_2019/07	GLASS01	5	30,0%
09/08/2019	MPE_ISA_GLASS_2019/07	GLASS02	1	80,0%
09/08/2019	MPE_ISA_GLASS_2019/07	GLASS04	15	70,0%
09/08/2019	MPE_ISA_GLASS_2019/07	GLASS05	0	0,0%
09/08/2019	MPE_ISA_GLASS_2019/07	GLASS07	0	0,0%
09/08/2019	MPE_ISA_GLASS_2019/07	GLASS03	0	0,0%
27/08/2019	MPE_ISA_GLASS_2019/07	GLASS07	0	0,0%
27/08/2019	MPE_ISA_GLASS_2019/07	GLASS00	4	70,0%
27/08/2019	MPE_ISA_GLASS_2019/07	GLASS01	10	85,0%
27/08/2019	MPE_ISA_GLASS_2019/07	GLASS02	1	95,0%
27/08/2019	MPE_ISA_GLASS_2019/07	GLASS04	15	100,0%
27/08/2019	MPE_ISA_GLASS_2019/07	GLASS04_1	11	100,0%
27/08/2019	MPE_ISA_GLASS_2019/07	GLASS03	2	60,0%
27/08/2019	MPE_ISA_GLASS_2019/07	GLASS05	0	0,0%
27/08/2019	MPE_ISA_GLASS_2019/07	GLASS06	2	20,0%

Figure 18 - T_TASK_ACTUAL

The database is now complete. One-to-one or one-to-many relationships are set up to link the master tables and related tables. The construction of the database is as follows:

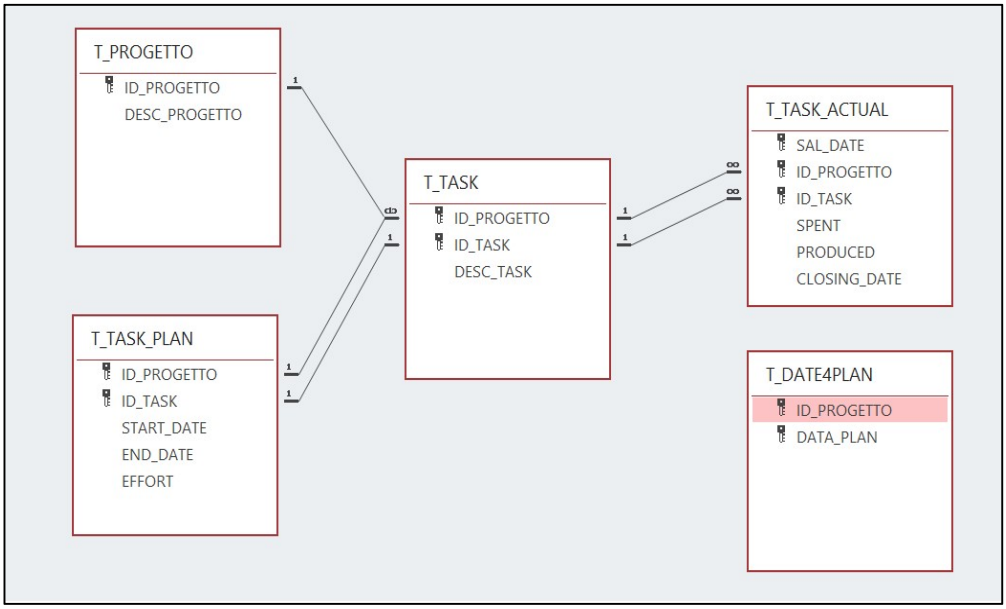

Figure 19 - Relations between Master Tables

5.2.1.2 Creation of Queries

Through queries, master tables are queried to create useful outputs[11] for EVA.

The reasons why queries are created and launched are:

- Record the current project situation from time to time and be able to export the data without affecting the master tables;
- Create a historical project data thanks to the exported data.

The Q_PLANNED query simply shows the tables T_DATE4PLAN and T_TASK_PLAN together to display the project plan. Below is the construction of the query and its output when it is launched.

[11] The outputs are shown in Excel export to view the table columns entirely.

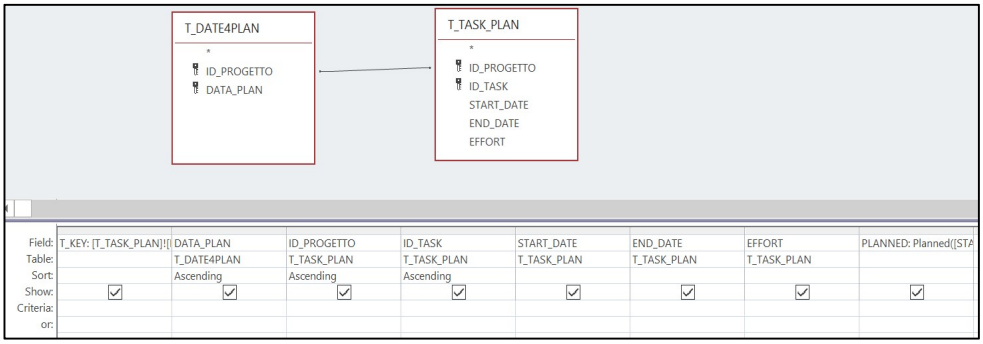

Figure 20 - Q_PLANNED

T_KEY	DATA_PLAN	ID_PROGETTO	ID_TASK	START_DATE	END_DATE	EFFORT	PLANNED
MPE_ISA_GLASS_2019/07--15/07/2019	15/07/2019	MPE_ISA_GLASS_2019/07	GLASS00	15/07/2019	20/09/2019	5	0
MPE_ISA_GLASS_2019/07--15/07/2019	15/07/2019	MPE_ISA_GLASS_2019/07	GLASS01	15/07/2019	09/08/2019	20	0
MPE_ISA_GLASS_2019/07--15/07/2019	15/07/2019	MPE_ISA_GLASS_2019/07	GLASS02	15/07/2019	19/07/2019	5	0
MPE_ISA_GLASS_2019/07--15/07/2019	15/07/2019	MPE_ISA_GLASS_2019/07	GLASS03	26/08/2019	30/08/2019	5	0
MPE_ISA_GLASS_2019/07--15/07/2019	15/07/2019	MPE_ISA_GLASS_2019/07	GLASS04	22/07/2019	13/09/2019	15	0
MPE_ISA_GLASS_2019/07--15/07/2019	15/07/2019	MPE_ISA_GLASS_2019/07	GLASS04_	22/07/2019	13/09/2019	15	0
MPE_ISA_GLASS_2019/07--15/07/2019	15/07/2019	MPE_ISA_GLASS_2019/07	GLASS05	02/09/2019	06/09/2019	5	0
MPE_ISA_GLASS_2019/07--15/07/2019	15/07/2019	MPE_ISA_GLASS_2019/07	GLASS06	09/09/2019	20/09/2019	5	0
MPE_ISA_GLASS_2019/07--15/07/2019	15/07/2019	MPE_ISA_GLASS_2019/07	GLASS07	23/09/2019	27/09/2019	5	0
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	MPE_ISA_GLASS_2019/07	GLASS00	15/07/2019	20/09/2019	5	6
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	MPE_ISA_GLASS_2019/07	GLASS01	15/07/2019	09/08/2019	20	6
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	MPE_ISA_GLASS_2019/07	GLASS02	15/07/2019	19/07/2019	5	5
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	MPE_ISA_GLASS_2019/07	GLASS03	26/08/2019	30/08/2019	5	0
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	MPE_ISA_GLASS_2019/07	GLASS04	22/07/2019	13/09/2019	15	0
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	MPE_ISA_GLASS_2019/07	GLASS04_	22/07/2019	13/09/2019	15	0
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	MPE_ISA_GLASS_2019/07	GLASS05	02/09/2019	06/09/2019	5	0
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	MPE_ISA_GLASS_2019/07	GLASS06	09/09/2019	20/09/2019	5	0
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	MPE_ISA_GLASS_2019/07	GLASS07	23/09/2019	27/09/2019	5	0
MPE_ISA_GLASS_2019/07--09/08/2019	09/08/2019	MPE_ISA_GLASS_2019/07	GLASS00	15/07/2019	20/09/2019	5	20
MPE_ISA_GLASS_2019/07--09/08/2019	09/08/2019	MPE_ISA_GLASS_2019/07	GLASS01	15/07/2019	09/08/2019	20	20
MPE_ISA_GLASS_2019/07--09/08/2019	09/08/2019	MPE_ISA_GLASS_2019/07	GLASS02	15/07/2019	19/07/2019	5	5
MPE_ISA_GLASS_2019/07--09/08/2019	09/08/2019	MPE_ISA_GLASS_2019/07	GLASS03	26/08/2019	30/08/2019	5	0
MPE_ISA_GLASS_2019/07--09/08/2019	09/08/2019	MPE_ISA_GLASS_2019/07	GLASS04	22/07/2019	13/09/2019	15	15
MPE_ISA_GLASS_2019/07--09/08/2019	09/08/2019	MPE_ISA_GLASS_2019/07	GLASS04_	22/07/2019	13/09/2019	15	15
MPE_ISA_GLASS_2019/07--09/08/2019	09/08/2019	MPE_ISA_GLASS_2019/07	GLASS05	02/09/2019	06/09/2019	5	0
MPE_ISA_GLASS_2019/07--09/08/2019	09/08/2019	MPE_ISA_GLASS_2019/07	GLASS06	09/09/2019	20/09/2019	5	0

Figure 21 - Q_PLANNED Output

Secondly, after querying for scheduled values, the same is done to display actual values.

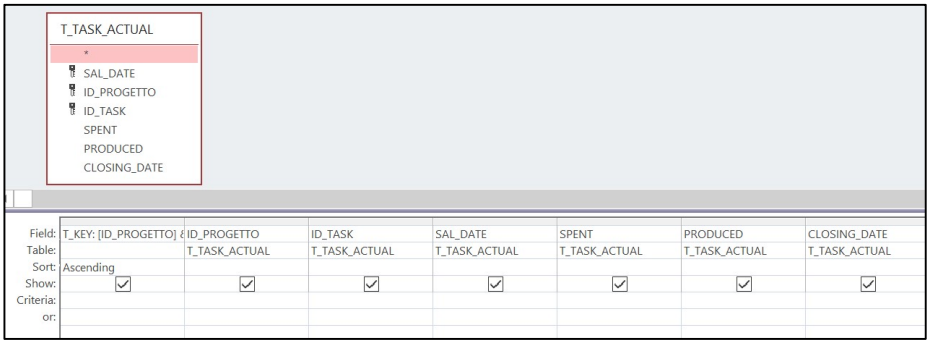

Figure 22 - Q_TASK_ACTUAL

T_KEY	ID_PROGETTO	ID_TASK	SAL_DATE	SPENT	PRODUCED
MPE_ISA_GLASS_2019/07--09/08/2019	MPE_ISA_GLASS_2019/07	GLASS06	09/08/2019	0	0,00%
MPE_ISA_GLASS_2019/07--09/08/2019	MPE_ISA_GLASS_2019/07	GLASS01	09/08/2019	5	30,00%
MPE_ISA_GLASS_2019/07--09/08/2019	MPE_ISA_GLASS_2019/07	GLASS02	09/08/2019	1	80,00%
MPE_ISA_GLASS_2019/07--09/08/2019	MPE_ISA_GLASS_2019/07	GLASS04	09/08/2019	15	70,00%
MPE_ISA_GLASS_2019/07--09/08/2019	MPE_ISA_GLASS_2019/07	GLASS05	09/08/2019	0	0,00%
MPE_ISA_GLASS_2019/07--09/08/2019	MPE_ISA_GLASS_2019/07	GLASS07	09/08/2019	0	0,00%
MPE_ISA_GLASS_2019/07--09/08/2019	MPE_ISA_GLASS_2019/07	GLASS03	09/08/2019	0	0,00%
MPE_ISA_GLASS_2019/07--22/07/2019	MPE_ISA_GLASS_2019/07	GLASS02	22/07/2019	1	30,00%
MPE_ISA_GLASS_2019/07--22/07/2019	MPE_ISA_GLASS_2019/07	GLASS04	22/07/2019	7	30,00%
MPE_ISA_GLASS_2019/07--22/07/2019	MPE_ISA_GLASS_2019/07	GLASS03	22/07/2019	0	0,00%
MPE_ISA_GLASS_2019/07--22/07/2019	MPE_ISA_GLASS_2019/07	GLASS05	22/07/2019	0	0,00%
MPE_ISA_GLASS_2019/07--22/07/2019	MPE_ISA_GLASS_2019/07	GLASS06	22/07/2019	0	0,00%
MPE_ISA_GLASS_2019/07--22/07/2019	MPE_ISA_GLASS_2019/07	GLASS01	22/07/2019	2	10,00%
MPE_ISA_GLASS_2019/07--22/07/2019	MPE_ISA_GLASS_2019/07	GLASS07	22/07/2019	0	0,00%
MPE_ISA_GLASS_2019/07--27/08/2019	MPE_ISA_GLASS_2019/07	GLASS03	27/08/2019	2	60,00%
MPE_ISA_GLASS_2019/07--27/08/2019	MPE_ISA_GLASS_2019/07	GLASS05	27/08/2019	0	0,00%
MPE_ISA_GLASS_2019/07--27/08/2019	MPE_ISA_GLASS_2019/07	GLASS02	27/08/2019	1	95,00%
MPE_ISA_GLASS_2019/07--27/08/2019	MPE_ISA_GLASS_2019/07	GLASS04_1	27/08/2019	11	100,00%
MPE_ISA_GLASS_2019/07--27/08/2019	MPE_ISA_GLASS_2019/07	GLASS07	27/08/2019	0	0,00%
MPE_ISA_GLASS_2019/07--27/08/2019	MPE_ISA_GLASS_2019/07	GLASS04	27/08/2019	15	100,00%
MPE_ISA_GLASS_2019/07--27/08/2019	MPE_ISA_GLASS_2019/07	GLASS00	27/08/2019	4	70,00%
MPE_ISA_GLASS_2019/07--27/08/2019	MPE_ISA_GLASS_2019/07	GLASS01	27/08/2019	10	85,00%
MPE_ISA_GLASS_2019/07--27/08/2019	MPE_ISA_GLASS_2019/07	GLASS06	27/08/2019	2	20,00%

Figure 23 - Q_TASK_ACTUAL_OUTPUT

The Q_DATA query shows the data of the project tasks to get an overview of what has been planned and current progress, by querying the previous Q_PLANNED and Q_TASK_ACTUAL. For each task and for each date, the monetary values of planned cost, actual cost and earned value are computed in terms of cost and invoicing value.

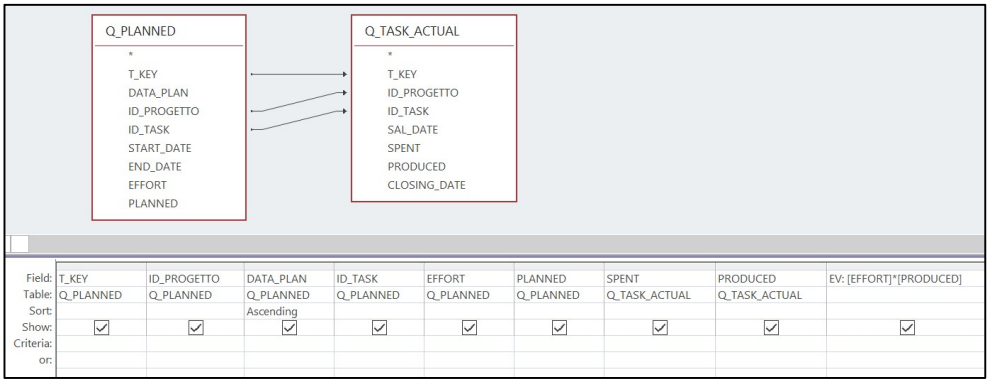

Figure 24 - Q_DATA

T_KEY	DATA_PLAN	PLANNED	ID_TASK	PV_COST	PV_INV	AC_COST	AC_INV
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	0	GLASS04_1	0,00 €	0,00 €		
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	6	GLASS01	600,00 €	780,00 €	200,00 €	260,00 €
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	0	GLASS06	0,00 €	0,00 €	0,00 €	0,00 €
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	5	GLASS02	500,00 €	650,00 €	100,00 €	130,00 €
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	0	GLASS03	0,00 €	0,00 €	0,00 €	0,00 €
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	0	GLASS07	0,00 €	0,00 €	0,00 €	0,00 €
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	0	GLASS05	0,00 €	0,00 €	0,00 €	0,00 €
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	0	GLASS04	0,00 €	0,00 €	700,00 €	910,00 €
MPE_ISA_GLASS_2019/07--22/07/2019	22/07/2019	5	GLASS00	500,00 €	650,00 €		
MPE_ISA_GLASS_2019/07--09/08/2019	09/08/2019	5	GLASS02	500,00 €	650,00 €	100,00 €	130,00 €
MPE_ISA_GLASS_2019/07--09/08/2019	09/08/2019	15	GLASS04	1.500,00 €	1.950,00 €	1.500,00 €	1.950,00 €
MPE_ISA_GLASS_2019/07--09/08/2019	09/08/2019	15	GLASS04_1	1.500,00 €	1.950,00 €		
MPE_ISA_GLASS_2019/07--09/08/2019	09/08/2019	0	GLASS07	0,00 €	0,00 €	0,00 €	0,00 €
MPE_ISA_GLASS_2019/07--09/08/2019	09/08/2019	0	GLASS03	0,00 €	0,00 €	0,00 €	0,00 €
MPE_ISA_GLASS_2019/07--09/08/2019	09/08/2019	0	GLASS05	0,00 €	0,00 €	0,00 €	0,00 €
MPE_ISA_GLASS_2019/07--09/08/2019	09/08/2019	5	GLASS00	500,00 €	650,00 €		
MPE_ISA_GLASS_2019/07--09/08/2019	09/08/2019	20	GLASS01	2.000,00 €	2.600,00 €	500,00 €	650,00 €

Figure 25 - Q_DATA Output

At the end of this procedure it is possible to set the final query for the Earned Value Analysis, Q_SAL[12], by computing the cumulate values of Q_DATA.

[12] SAL means Project Progress Status.

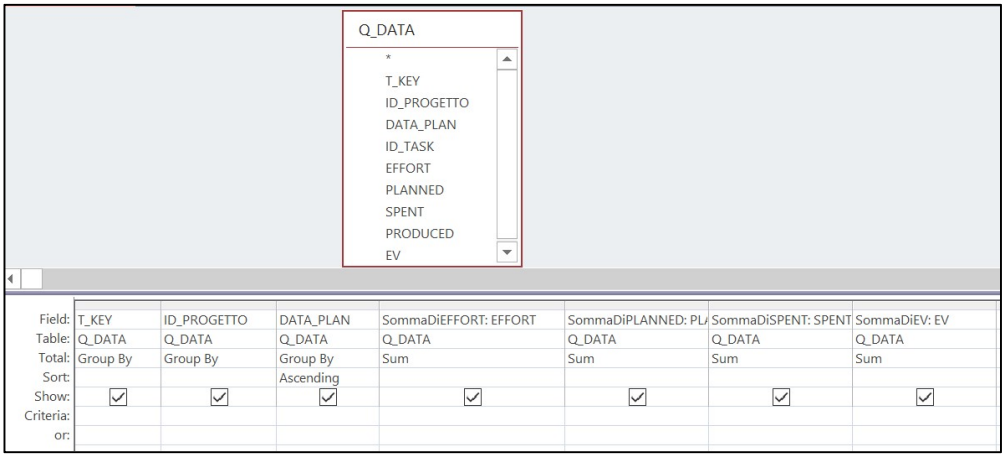

Figure 26 - Q_SAL

T_KEY	ID_PROGETTO	DATA_PLAN	SommaDiEFFORT	SommaDiPLANNED	SommaDiSPENT	EV
MPE_ISA_GLASS_2019/07--15/07/2019	MPE_ISA_GLASS_2019/07	15/07/2019	80	0		
MPE_ISA_GLASS_2019/07--22/07/2019	MPE_ISA_GLASS_2019/07	22/07/2019	80	17	10	8,00
MPE_ISA_GLASS_2019/07--09/08/2019	MPE_ISA_GLASS_2019/07	09/08/2019	80	75	21	20,50
MPE_ISA_GLASS_2019/07--27/08/2019	MPE_ISA_GLASS_2019/07	27/08/2019	80	113	45	59,25
MPE_ISA_GLASS_2019/07--02/09/2019	MPE_ISA_GLASS_2019/07	02/09/2019	80	128		
MPE_ISA_GLASS_2019/07--09/09/2019	MPE_ISA_GLASS_2019/07	09/09/2019	80	148		
MPE_ISA_GLASS_2019/07--16/09/2019	MPE_ISA_GLASS_2019/07	16/09/2019	80	117		
MPE_ISA_GLASS_2019/07--23/09/2019	MPE_ISA_GLASS_2019/07	23/09/2019	80	75		
MPE_ISA_GLASS_2019/07--30/09/2019	MPE_ISA_GLASS_2019/07	30/09/2019	80	80		

Figure 27 - Q_SAL Output

5.2.1.3 Modules

To compare END field with CLOSING_DATE a module is created: M_DELAY. Outputs of the module are:

- Not Delivered;
- Delivered With Delay;
- Delivered In Time.

```
Public Function Delay_Id(fine, closing_date) As String

Dim p_closing_date As Integer


If IsNull(closing_date) Then
  p_closing_date = 0
 Else
  p_closing_date = 1
End If

If p_closing_date = 0 Then
     Delay_Id = "Not Delivered"
     Exit Function
End If

If p_closing_date = 1 Then
    If fine < closing_date Then
        Delay_Id = "Delivered With Delay"
       Else
        Delay_Id = "Delivered In Time"
    End If
End If

End Function
```

Figure 28 - M_DELAY

While to compare PRODUCED field with CLOSING_DATE and END the module M_STATUS is created. Possible outputs are:

- Completed;
- Not Completed;
- Wrong Data.

```
Public Function Stato_Id(produced, closing_date) As String

Dim p_closing_date As Integer


If IsNull(closing_date) Then
  p_closing_date = 0
 Else
  p_closing_date = 1
End If

If p_closing_date = 0 And produced = 1 Then
     Stato_Id = "WRONG DATA !!!!"
     Exit Function
End If

If p_closing_date = 1 And produced <> 1 Then
     Stato_Id = "WRONG DATA !!!!"
     Exit Function
End If

If produced = 1 Then
    Stato_Id = "Completed"
    Exit Function
End If

 Stato_Id = "Not Completed"
```

Figure 29 - M_STATUS

6 USE CASE STUDY

"Startup Your Life"[13] project of iSAPIENS is a project taken over by Amarìs after a Governance activity by Amarìs itself which has demonstrated inefficiency and neglect by the previous contractor.

The project was therefore entrusted to the COE Amarìs team already in the running and with no documentation at the delivery step. The team tried to reconstruct a collection of requirements and to proceed with the implementation already started by the previous contractor to try to go live with the first wave as soon as possible.

The partnership between UniCredit and iSAPIENS has given birth to Startup Your Life, a three-year path that covers the need for work-school alternation for all types of schools; offers learning opportunities through an innovative online platform, classroom moments with the assistance of bank tutors and school tutors and development of project activities.

The scope of the project is to build the platform for accessing online courses for students, teachers and staff of schools in Lombardy. A school-work alternation activity with a strong social impact value. A complex project whose ultimate goal is to contribute to the development of the community by involving the young people of Generation Z to increase their financial skills, encouraging their entrepreneurial spirit and generating a widespread and measurable social impact.

Amarìs was commissioned by iSAPIENS for the creation of the online platform, managing and setting users and accesses customized according to the user types (professor/student/administrator) and the school to which they belong.

[13] See L

The Agile team proceeded by placing the tasks on the Kanban Dashboard on Jira, involving the customer and facilitating the communication system. To date, at the end of the Wave1 delivered, all items (tasks) are in Production column.

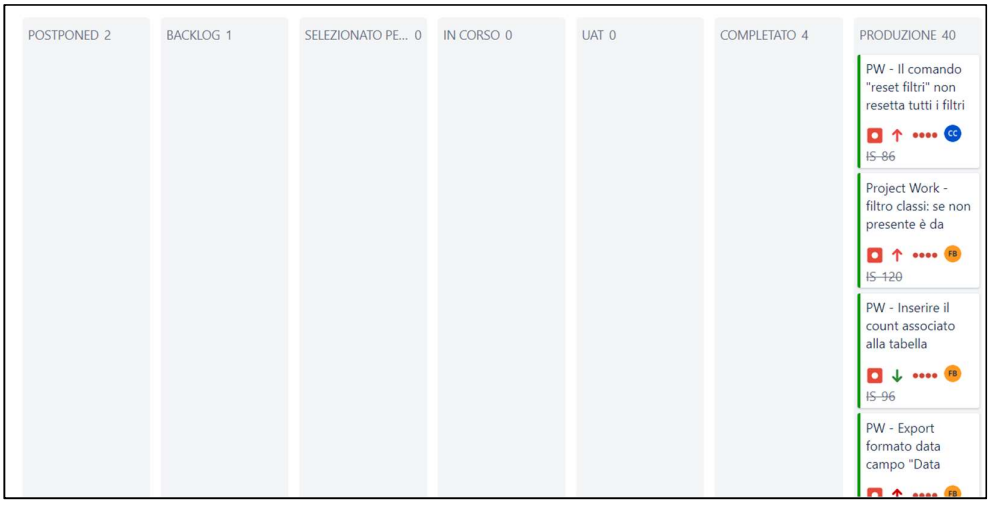

Figure 30 - Jira Kanban Board of iSAPIENS

For this project it was decided to start building a customized support for the PM. By abandoning scheduling on MS Project, the Agile team setting on Jira was integrated with Database Access.

With the list of items on Jira, a list of tasks, scheduling and monitoring plan was created. The database was built as above explained and on the monitoring dates the % P was recorded.

Thanks to the DB it was possible, first of all, to numerically display the progress of the project through the Earned Value Analysis, with all the values displayed.

The DB was tested only for the first project wave, with positive results. The PM keeps on using it for subsequent waves.

SAL_DATE	BAC	PV	AC		EV						
DATA_PLAN	EFFORT	PLANNED	SPENT	P%	EARNED	EAC	ETC	SPI	CPI	CV	SV
22/07/2019	80	16	10	10%	8	100	90	0,50	0,80	-2,0	-8
09/08/2019	80	60	21	26%	21	82	61	0,34	0,98	-0,5	-40
19/08/2019	80	60	26	32%	26	82	56	0,43	0,98	-0,5	-35
21/08/2019	80	60	26	45%	36	58	32	0,60	1,38	9,8	-24
26/08/2019	80	60	45	74%	59	61	16	0,99	1,32	14,3	-1
27/08/2019	80	62	45	74%	59	61	16	0,96	1,32	14,3	-3
28/08/2019	80	63	45	74%	59	61	16	0,94	1,32	14,3	-4
30/08/2019	80	65	45	87%	69	52	7	1,07	1,54	24,3	4
09/09/2019	80	70	53	90%	72	59	6	1,03	1,36	19,0	2
12/09/2019	80	74	53	90%	72	59	6	0,97	1,36	19,0	-2
17/09/2019	80	75	58	96%	77	61	3	1,02	1,32	18,5	2
18/09/2019	80	75	58	96%	77	61	3	1,02	1,32	18,5	2
26/09/2019	80	79	67	100%	80	67	0	1,01	1,19	13,0	1
18/10/2019	80	80	67	100%	80	67	0	1,00	1,19	13,0	0

Figure 31 - EVA in man-days

In the table, for each data planned, BAC, PV, AC and P% are tracked. For each date the values of indicators in grey are the result of the sum of the indicators for each task on that date, exporting in Excel the query Q_SAL. Orange columns contain the values of indicators computed as explained in the Chapter 4.

The calculation can be made also in monetary terms: in this case it is useful to compute the cost margin of the project. These are the cumulative data of the tasks at the end of the project, exported to Excel to create the graphs and calculations of the project margin.

DATA_PLAN	PLANNED	PV_COST	PV_INVOICING	AC_COST	AC_INVOICING
22/07/2019	16	1.600,00 €	2.080,00 €	1.000,00 €	1.300,00 €
09/08/2019	60	6.000,00 €	7.800,00 €	2.100,00 €	2.730,00 €
19/08/2019	60	6.000,00 €	7.800,00 €	2.600,00 €	3.380,00 €
21/08/2019	60	6.000,00 €	7.800,00 €	2.600,00 €	3.380,00 €
26/08/2019	60	6.000,00 €	7.800,00 €	4.500,00 €	5.850,00 €
27/08/2019	62	6.200,00 €	8.060,00 €	4.500,00 €	5.850,00 €
28/08/2019	63	6.300,00 €	8.190,00 €	4.500,00 €	5.850,00 €
30/08/2019	65	6.500,00 €	8.450,00 €	4.500,00 €	5.850,00 €
09/09/2019	70	7.000,00 €	9.100,00 €	5.300,00 €	6.890,00 €
12/09/2019	74	7.400,00 €	9.620,00 €	5.300,00 €	6.890,00 €
17/09/2019	75	7.500,00 €	9.750,00 €	5.800,00 €	7.540,00 €
18/09/2019	75	7.500,00 €	9.750,00 €	5.800,00 €	7.540,00 €
26/09/2019	79	7.900,00 €	10.270,00 €	6.700,00 €	8.710,00 €
18/10/2019	80	8.000,00 €	10.400,00 €	6.700,00 €	8.710,00 €

Figure 32 - iSAPIENS Earned Value Analysis

The monetary data are exported from the query Q_SAL_VALUE, same query as before but in monetary terms.

The effort for the project's W1 is estimated at 80 man-days.

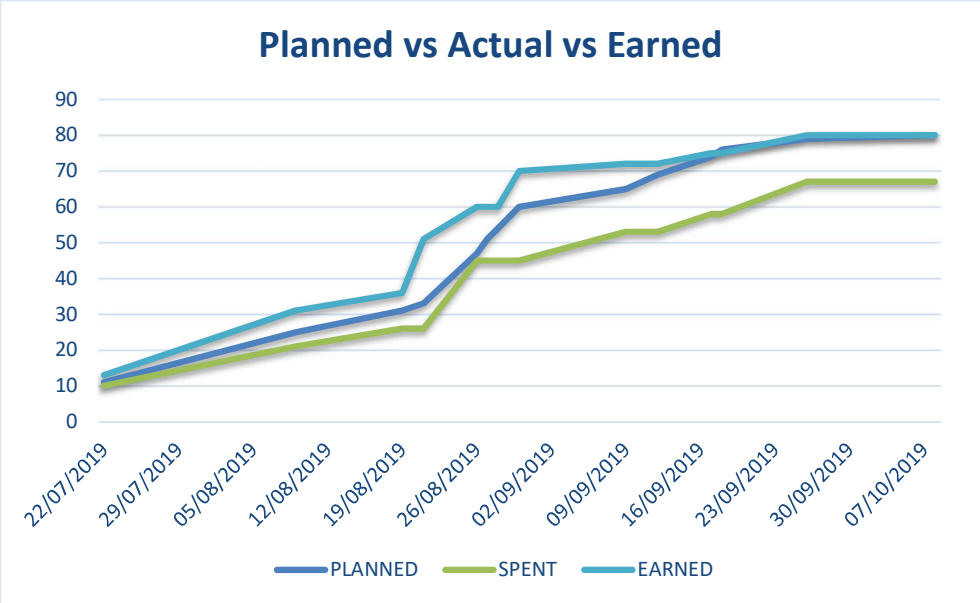

Figure 33 - iSAPIENS project metrics

It can be seen that since the first project phase, the AC (spent) is always less than PV. The peak of this performance is reached after about a month from the beginning of the project implementation, visible in terms of Performance Indicators. We note in the more explanatory graph (Figure 33) that the value of AC deviates most from the value of PV, with an EV of 60 days.

In the next phase the EV remains constant, with less scheduling variance and lower cost (Figure 36).

In the final sprint of W1 it is noted that Earned Value reaches its maximum value, equal to Planned Value, so the wave is requiring less economic resources than expected and is ahead of schedule. In fact, the wave was completed 13 days before the planned, as shown by ETC value (Figure 37) at 26 September and equal to 0 (scheduling term at 8th October). The correspondence is also evident in the graph of the Variance To Completion (Figure 36) where the final value of VTC is not 0 but is 13, demonstrating the fact that the project ended earlier than expected.

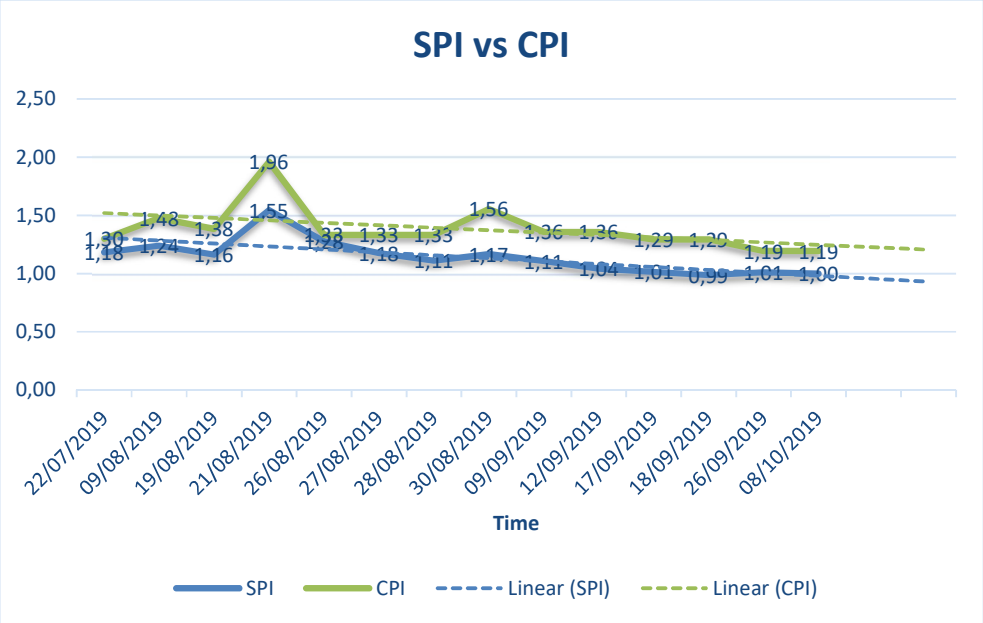

Figure 34 - iSAPIENS Indexes

In Wave1 it is noted that the SPI values are higher than those of CPI, but both indicators are always greater than 1, so the wave is requiring less economic resources than expected and is ahead of schedule.

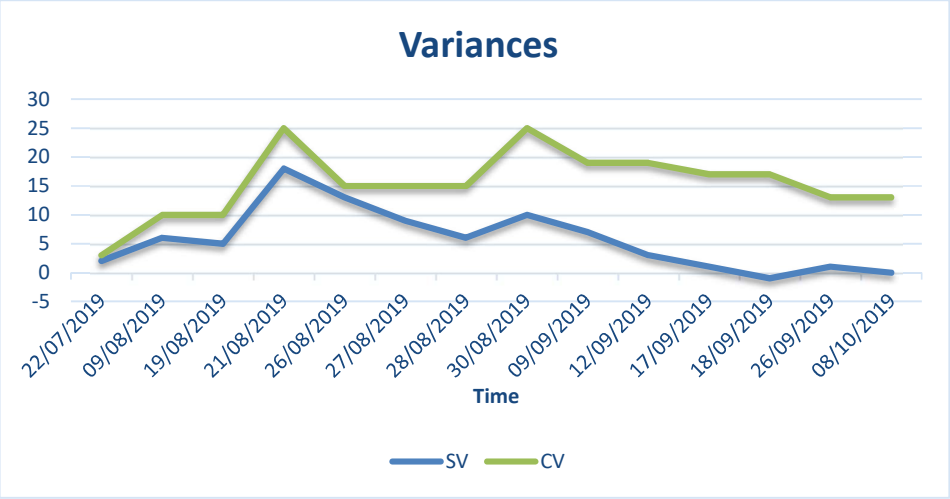

Figure 35 - iSAPIENS Variances

The design variances indicate how far planning differs from the real progress of the activities. During almost the entire project we have positive variances, and this indicates an overestimation of the duration of the activities and the related costs. Theoretically it may not be a positive aspect for the PM, but actually it depends on the type of contract and payment scheme that the contractor has with the customer. In turnkey delivery, with lump-sum payment (Amarìs case) it is good ability of the PM to overestimate the activities to have positive profit margins and to be able to make the customer pay little more than what is being spent.

In this case it can therefore be said that the PM has done an excellent job in terms of planning and efficiency in development. The efficiency of this project has benefits over other ongoing projects.

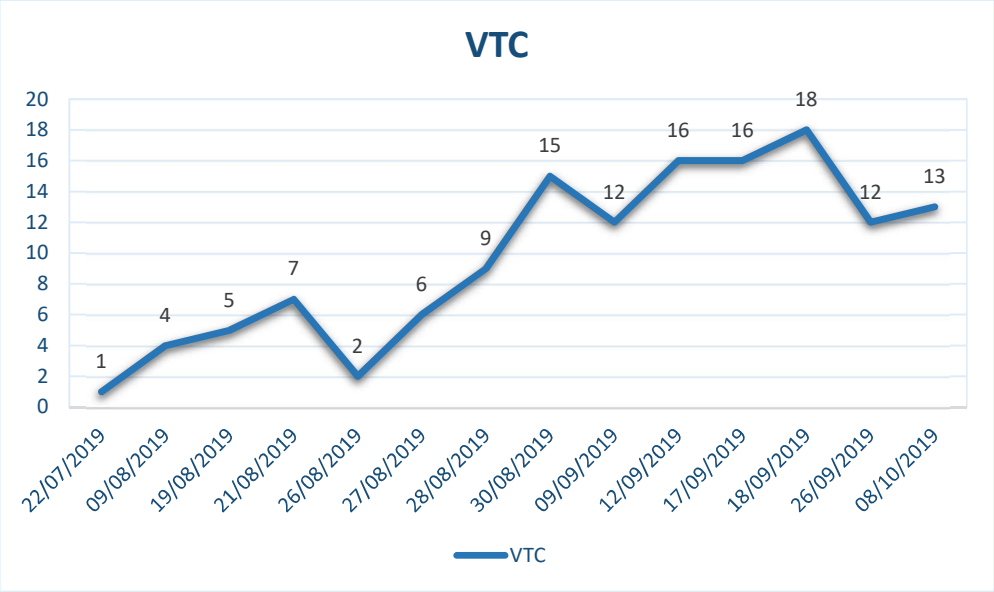

Figure 36 – iSAPIENS Variance To Completion

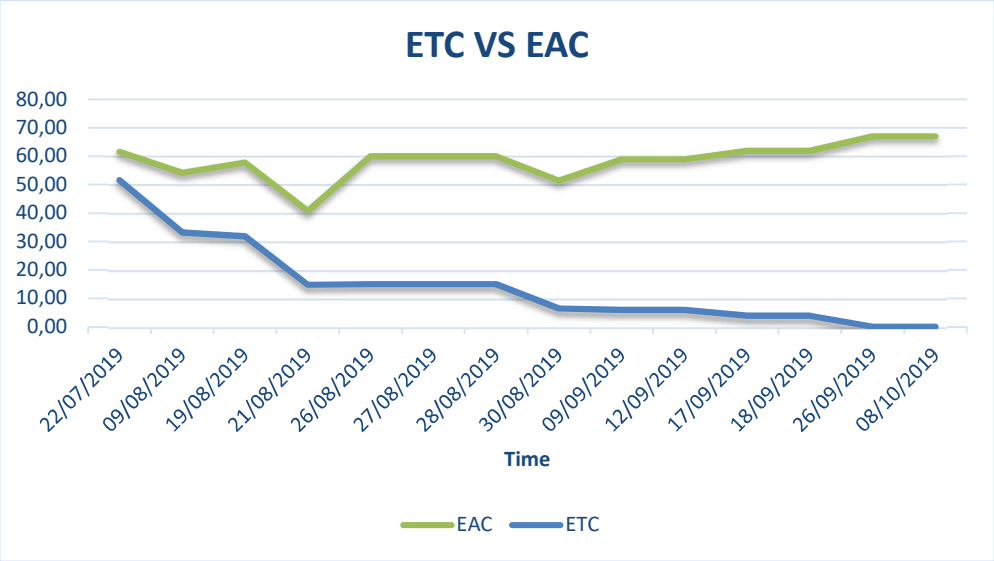

Figure 37 - iSAPIENS Estimations

During the project, it is possible to estimate what the actual budget spent at the end of the project (Estimate At Completion) and how much budget, at the monitoring date, is needed to complete the project (Estimate To Completion). Notice how these two indicators are increasingly divergent from each other.

Estimate At Completion increases more and more: initially there is an underestimation due to an excellent initial performance, while later it settles at a value that can be lower or higher than the planned effort (BAC). In this case, as already explained, the value is less than 80. Estimate To Completion instead decreases during the progress of the project, until it reaches zero when the tasks have all been completed. In this case 13 days ahead of schedule.

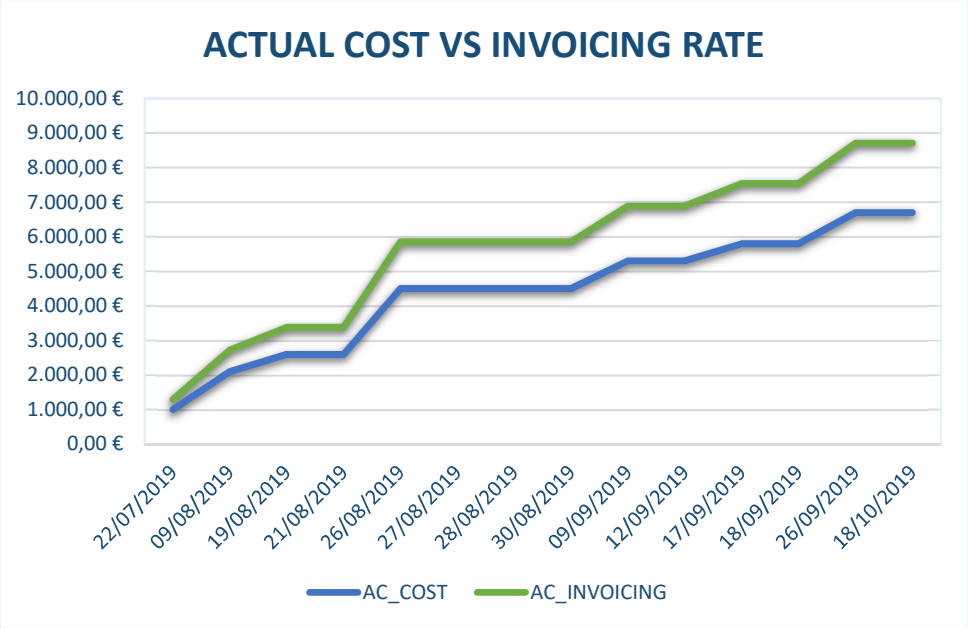

Figure 38 - iSAPIENS Costs and Invoicing Rate

The latter graph relates the actual costs for the Amaris contractor, and the invoices issued to the customer. At the end of the first project wave these two values are very different.

Using fictitious values, according to which, as already mentioned, the unit cost of a man-day is 100 and the billing submitted to the customer is increased by 30% (130), the gross project margin can be verified at the end of the first wave.

$$Gross\ Margin = \frac{Invoincing\ Value - Actual\ Costs}{Invoicing\ Value}$$

In the specific case:

$$Actual\ Cost = \ 6.700{,}00\ €$$

$$Planned\ Value\ (Budget\ at\ Completion) = \ 8.000{,}00\ €$$

$$Invoicing\ Value = \ 10.400{,}00\ €$$

Without a fixed-price contract at the end of the project, the bill would have been the current cost increased by 30%, that is € 8,710.00. High profit margins can be obtained with an *a priori* fixed price if properly planned.

$$Gross\ Margin = \frac{(10.400{,}00\ € - 6.700{,}00\ €)}{10.400{,}00\ €} = 36\%$$

The client still pays the agreed effort, 80 man-days on the project. The client cannot decide which resources actually work on the project or their seniority level. The Agile method, however, provides for high transparency towards the customer, together with his total involvement through the Kanban Dashboard. In this project, the two approaches meet perfectly in a hybrid approach: the PM plans the best execution of the project in order to make profit margins for the contractor company, while the resources make sure that the customer is always satisfied by involving him in every significant progress (release sprint).

6.1 DISCUSSION OF RESULTS

The Access database has proven to be a valid tool for supporting Project Management because:

- The launch of the queries, as well as their updating, leads to the latest version of Q_SAL which, exported to Excel, contains the data useful for EVA;
- Through VBA, it is possible to create a lot of automations of exports, reports, and updates. The programming language is simple and affordable for everyone;

- The latter export is saved and frozen and a photograph of the project situation remains for that specific monitoring date;
- With other tools such as MS project, updating the data inevitably leads to the cancellation of the previous ones;
- On the other hand, with Excel, by linking several spreadsheets, it would not be possible to force the referential integrity of the data or update the primary (master) tables without changing all the other sheets;
- The efficiency of the project (completed 13 days in advance with a profit margin of 36%) can be spread on other projects, allowing consultants with more workloads to count on other activities;
- It is tailored to the type of contract adopted, as the utility of the turnkey projects is to be able to contract a certain number of man-days and spend a different number of man-days, to then use the earned value on other projects;
- If more than one project is entered and the tasks are properly linked to the consultants in charge, the resource can be assessed in its overall work, as can the entire team, evaluating an overall margin of all the projects.

The Project Manager has entered the data of the second wave of the iSAPIENS project and of a project related to a new customer. However, the value of the team's overall efficiency and profit margin was not verified for this thesis. Appropriate metrics must be studied for these estimates, as the new approach, applied cumulatively, obviously tends to overestimate the team's efficiency and projects' profit margin.

The imminent future development is therefore primarily to find an adequate metric, such as for example weighting the outputs of the projects based on their overall effort and the rate applied for invoicing.

Coming now to the less positive aspects, first of all is the data processing capability of Microsoft Access. With dozens of tables and dozens of queries, the database currently in the hands of the PM is sometimes slow in processing data.

If, however, the tool setting seems to be *ad hoc* for the case of Amarìs, the future development can be an optimization with a SQL database of more advanced technology.

The second slightly negative aspect is the Access user interface: tables and queries are listed on the left side of the interface; they can be organized in subgroups but in any case, in a list that if very long, is not user-friendly.

In conclusion, the setting of the tool and its functionality have proved successful with positive feedback from the Project Manager. Earned Value analysis is facilitated. Last but not least, the hybrid approach finally tested is successful, combining Agile frameworks, which the development team must certainly consolidate, with precise and rigid planning on the project management side.

CONCLUSION

The thesis work was to define real and concrete planning and monitoring practices for project management, starting from the theory and the *AS IS* model in the company.

The need of the Project Manager to be met was a customized tool for supervising different projects. Behind this need, during the study of the *AS IS* model, several other needs and cracks emerged in the conduct of the projects, which were clarified and solved to arrive at the tool design.

First of all, since about a year, Amarìs has adopted the remote delivery method, with turnkey contract projects. Initially the consultancy in the Turin office was provided in Time and Material or remotely only for assistance services (AMS for SAP). It has been difficult therefore to make consultants and employees understand the potential and usefulness of the turnkey contractual mode. The customer pays a fixed price for an agreed number of man-days of work. It is clear that the contractor has an interest in using fewer man-days than those that have been paid, without affecting the final result. It is also clear that the contractor must be able to draw up a project plan by overestimating the timing, however, that is acceptable to the customer. This contract allows, combining the know-how and great efficiency (end less than scheduled), to obtain large profit margins for the contractor and great satisfaction with zero effort for the client.

Secondly, in addition to the new contractual formula, Amarìs Torino has decided to open up to a new type of project: initially the expertise was only SAP, now thanks to new hires and the formation of a new team, mobile application projects, microservices, web applications and web services are taken in charge. The new team develops according to Agile methodologies which include continuous interview with the stakeholders, the participation of the client during the progress of the activities and subsequent releases (sprints) of the product or parts of it. Customer interaction, ongoing communication and updates are not in

line with the turnkey contract. The Jira (Kanban Dashboard) platform used by the Agile development team must be integrated with other planning and monitoring tools. Agile must be incorporated in a rigorous environment, where documentation has a fundamental role and must respect certain standards, but also the profits and progress times must be significant for the company as a whole, not for a project itself.

A hybrid approach in project management was therefore suggested, where the new team works following some Agile frameworks but is supervised by the Project Manager who directs the work also on the basis of the progress of other projects. This thesis describes in detail this hybrid approach adopted, starting from the theory of project management and adapting it to the real case of Amarìs.

Thirdly, the management of turnkey projects is influenced by the figure who coordinates them. In Amarìs Turin there is only one Project Manager, head of the company delivery (delivery manager) section, both for SAP projects (implemented with a purely waterfall approach) and for new Agile implementation projects. These are IT projects coordinated by a project manager who must report to his superiors on the progress of the Turin section in general, and to the steering committee on the progress of a particular project.

In this regard, it was thought that the Earned Value Analysis is the most suitable monitoring technique for a project. It is preceded by a precise and widespread planning activity, fundamental also for the management of turnkey projects, and is characterized by a punctual and periodic monitoring, not downstream, but throughout the course of the project. Outliers are immediately identified and traced back to a cause / event, so as to implement corrective measures where appropriate.

From this model derived the need for a customized tool to facilitate the Earned Value Analysis, since the software in use (as well as the MS Project) does not

allow storing the data nor to aggregate the data for the type of reporting described above.

The unique metric identified for different project is the Earned Value Analysis, the tool designed as a solution, instead, is a single customized database on Access. The tool aims to demonstrate the feasibility of a database as a solution to the problem of project monitoring in the reality of IT consultancy, and it has been tested with data of a project by iSAPIENS.

The tool allows the Project Manager to have an overview of the progress of the projects and supervised teams. Thanks to the referential integrity of the data, which cannot be forced either on Excel or on other tools on the market for project management, a performance assessment can also be made on a single consultant. Furthermore, the integrity of the data over time is no less important: the master tables are updated only by launching queries which, exported from time to time, constitute photographs of the state of the project over time for each monitoring date. This is extremely important for future estimation and planning activities, which are often done in the IT area on the basis of past experience.

It should also be underlined the convenience of a single tool which replaces several MS Project files, one for each project, to be updated periodically. The importance of this aspect concerns the reallocation of resources: if a team or sub-team is performing in an excellent way, spending less man days than expected and therefore with a significant earned value, the resources of this group can be assigned to other projects, carrying on the work and acquiring new customers. This efficiency cannot be achieved if the Project Manager does not have an overview (aggregate numbers) of the projects he supervises. The optimal management of resources involves high profit margins and, as in the case study, extra margins.

The tool is being tested on multiple projects simultaneously and the search for metrics and indicators for corrective actions and reallocation of resources. The suggested future development is to build a database with better potential than

that built on Access, but following the design and relationships described in this thesis in the *TO BE* model. This is necessary for a better user interface and for a better data processing capacity of the tool.

To sum up, the design of the database and its functionality have proven effective with positive feedback from the Project Manager, who uses it daily to update it and to add new projects. The Earned Value analysis is facilitated and can be done on a single project or on aggregated data to evaluate the progress of the Turin delivery section. Furthermore, the hybrid approach has been put into practice simultaneously with the database on this new project successfully. Agile frameworks have been combined, which the development team must certainly consolidate, with precise and rigid planning on the side of project management.

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