Integrated Project Control System based on EVM methodology: a case history for Quadrilatero programme, Italy [1]

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Abstract

The paper describes the implementation of an integrated project control system on behalf of a public Owner in Italy, committed to the project management of a capital investment of two Billions (circa) of Euros regarding an infrastructure programme. The author leaded, as a project manager, the multidisciplinary consulting group on behalf of the JV which had awarded the consulting project named "Project Management System for Quadrilatero (PMS)".

The project controls system (PCS) described in this paper is a core part of the project management system (PMS) designed to support Quadrilatero, a public scope company acting as an owner of highways major scheme in Italy started in 2006. The author of this paper was the project manager of the project management consultancy group; he also designed CAPITOLO, the software package used for the implementation of the project controls system, based on EVM methodology.

The paper first describes the scope of work of PMS, and then focuses on the advanced project controls system implemented. At conclusions, also some lessons learned are provided.

1. Introduction

"*Quadrilatero*" was a multibillions infrastructures programme (over 2 billion Euros) of a major highways scheme across two regions in central Italy: Marche and Umbria. The Owner of the programme was a *public scope-company* owned by ANAS (National Autonomous Roads Corporation, under the control of Italian Ministry of Infrastructure and Transport).

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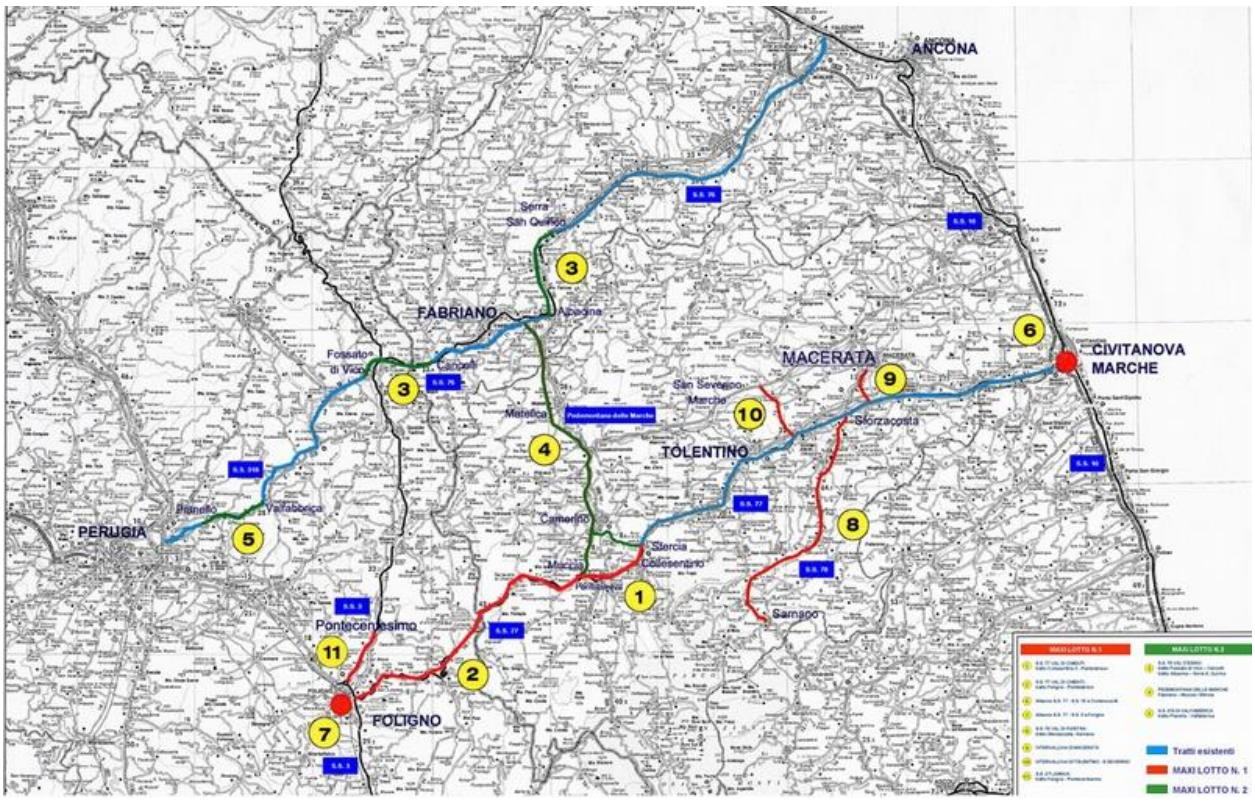

Fig. 1: Lot 1 in red ad Lot 2 in green; existing highways in blue

The entire Quadrilatero programme was complex; it included two sub-programmes: the execution of 160 km of highways, (sub programme PIV "*Piano Infrastrutture Viarie"*) and fifteen public private-partnership (PPP) projects based on concessions (sub programme PAV "*Piano Aree Vaste"*). These "*concessions"* (delivered on the base of a build operate transfer scheme) included the execution of more than 15 single projects along the axis of the highways, regarding malls, logistic platforms facilities, production plants, technological factories, etc.). The two sub-programmes, PIV and PAV are interconnected, as the financial balance of the whole program requires incomes linked to the timely delivery of the public concessions.
(Fig. 1 e 2)

The "*sub-programmes*" PIV was subdivided in two main Projects: Lot 1 and Lot 2, which were awarded in 2006 by two design-build contractors, formed by primary European construction companies.

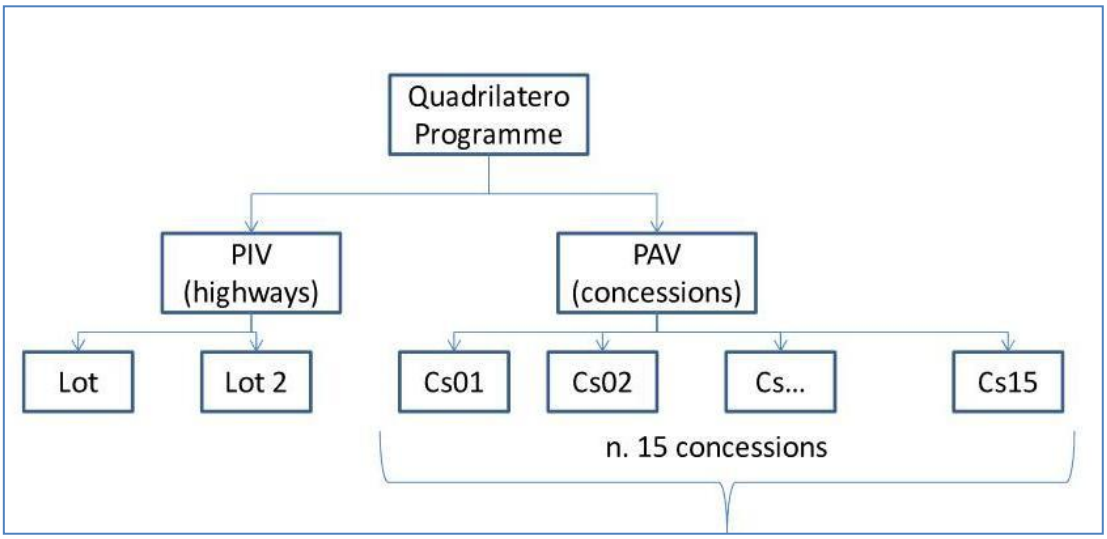

Fig. 2: Programme scheme

In October 2006, the Owner also selected a project management consultant, through an European tender, to execute a project management consultancy (PMC) project named *"Project Management System (PMS)"* targeted to the "*improvement and set up of the project management systems for Quadrilatero* ". PMS was awarded by a JV, hereafter named as the "*Consultant*", formed by three engineering and consultancy companies; the author of this paper was the project manager of the consulting team dedicated to PMS.

The technical offer submitted by the Consultant regarding the realization of the PMS was founded on a *core part*: an integrated project controls system, based on earned value management (EVM), which was implemented through a specific software tool named *CAPITOLO*, designed by the author. The project controls system is described in detail at par. 4., but for a better understanding of its capabilities it is first necessary a description of the whole scope of work of PMS.

2. The scope of work of the project management system (PMS)

The scope of PMS was the delivery a project management system for the Owner, hereafter named as the "*Client*", in order to improve its capability to manage effectively the whole Quadrilatero programme; in particular, the scope of work included specific deliverables which had to allow the controls of project management processes:

1. project organizing;
2. programme controls and monitoring;
3. communication including stakeholder management;
4. financial modeling for simulations;

5. a set of project management procedures (cost estimating, budgeting and cost control, planning and scheduling, progress measurement and payment, change management etc.);
6. training and know-how transferring.

2.1. Insight into technical offer

The contractual requirements (*terms of references*) did not specify the technical characteristics of the PMS deliverables, but they described specific problems and risks that the PMS would have solved; for example: risks of delay during the design and approvals processes for a large public programme, like Quadrilatero, involving many local authorities and stakeholders; the need to get a full control of the physical and economical progress of the single projects as well as of the whole programme, in order to monitor and forecast funding needs and addressing reporting needs toward various public entities. The focus of the terms of references allowed the bidder to conceive and design the best project management system addressing specific needs described by the Client. Our JV developed a detailed technical offer in order to specify, as much as possible, the results and performance of the PMS that would be implemented.

3. Basis of the PMS

The PMS designed by the Consultant was based on these parts:

1. integrated project controls system with effective capabilities of programme progress monitoring, performance measurement and reporting);
2. programme controls and governance framework;
3. project management team (PMT) integrated with Client's programme management team;
4. training programme for the Client's project management resources, to guarantee the proper knowledge transfer.
5. proposal for the establishment of a PMO (programme management office).

3.1. Integrated project controls system

The system is described in detail at par. 4

3.2. Programme controls and governance framework

This part plays a crucial role; it is composed by four packages:

a) project controls prescriptions;
b) project management procedures;
c) coordination procedures, including a communication plan between all the contractual parties and stakeholders;

d) project controls manual.

The *project controls (PC) prescriptions* are fundamental for the implementation of the project controls system within the environment of the programme. The PC prescriptions were imposed to two Design-Build Contractors involved in PIV programme, as well as to the concessionaires, who would have acted as developers in realizing the facilities of PAV programme. The PC prescriptions guarantee that all the Contractors shall use the same model in developing plans and schedules, the same progress measurement methods and a standard process for schedules management (baseline, re-baseline, schedule updates, recovery plans, rules for logic network development delay analysis) as well as the same reporting. To facilitate and guide to the right application of the above processes, specific terms of the prescriptions also imposed that the project controls processes would have been fully integrated into the *project quality management plans***.** The contractors, for their part, had to transfer the PC prescriptions to their subcontractors, in order to guarantee quality assurance at programme level. Other details regarding the PC prescriptions are provided in next paragraphs, as they are a part of the project controls system.

The *project management procedures* regulate the key project management processes: (cost estimating, budgeting and cost control, planning and scheduling, progress measurement and payment, change management, quality controls on site, etc.). The following procedures were developed:

progress measurement and payment
planning and scheduling, which were translated in the PC prescriptions already described
change management
claim management, including schedule delay analysis
quality management and quality control on site
environmental management
safety management on sites
hazards management on sites
interferences management (with various public and private entities for the execution of works)
lands expropriation management

The process of definition, review and approval of the above procedures had been challenged; it was necessary first to agree a general procedure ruling the process of review-approval with Client; after this agreement, several workshops were needed, taking into account that each of procedures involved different company's department.

The *coordination procedures* include communication plan between Client and others contractual parties involved in the execution and control of the Quadrilatero programme, as well as specific

procedures regarding the administration of the Contracts, to guarantee the full compliance with existing legal framework for public works. These "procedures" did not address technical aspects of project management processes, which were addressed through the project management procedures instead. (See lesson learned 1)

The *communication plan* was complex for the number of the contractual parties and stakeholders, as well as for the size and context of the programme, characterized by a heavy regulations framework, both for technical and administrations issues. The Consultant introduced and developed a detailed matrix which interrelates "channels of communication allowed" in regard of specific processes (e.g. detail design review, change evaluation and assessment). Detailed *communication charts* then were developed for each of the contractual party and for the Owner toward its stakeholders, specifying communication type (e.g. letter, email, meeting, reports, etc.).

The *project control manual* was a guide for the Client's team in using the integrated project controls system; the manual included the user guide for the software packages: CAPITOLO, Primavera, as well as user guide for the two interfaces between Primavera and CAPITOLO for transferring "actual dates" and "remaining durations" of the single work packages and between CAPITOLO and enterprise resource planning (ERP) tool, for transferring progress data.

3.3. Project management team

The Consultant had to provide a senior project management team (PMT) to integrate the Clients organization. The Consultant PMT was formed by:

1. project manager (*project leader*);
2. highways construction expert for lot 1;
3. highways construction expert for lot 2;
4. financial analyst;
5. IT quality systems expert;
6. project controls specialist;
7. public procurement expert.

The Consultant had also included in its technical offer an *advisory board* composed of three senior executives of the companies forming the JV:

- expert of design management;
- expert of project risk management;
- expert of project management system (acting also as the JV project manager).

The *advisory board* would have met periodically (tentatively every 3-4 months) at the Client's offices to monitor progress, budget and risks.

3.4. Training

The core topic of the training activity regarded project controls methodology and the use of the integrated project controls systems. The training programme started right after the start-up of the PMS project, in overlapping with the others activities of the Consultant to develop and implement the PMS. The training program included the following courses:

1° course: introduction to project management systems

This course was addressed to directors and senior functional department managers; this course had two main objectives:

- Provide an introduction to project management processes and cost engineering concepts, with a focus on organizational structures.
- Provide knowledge on earned value methodology to allow managers to understand capabilities of the project controls systems.

2° course: basic project controls

This course was addressed to the whole project management team, including project managers, design managers, construction managers, quality managers, etc. This course had three main objectives:

- Provide a basic project controls knowledge in order to allow an understanding of the concepts and methods of project controls management, like CPM scheduling, progress payments methods for lump-sum contracts.
- Provide a full description and explanation of the flow of the information and the organization of the project controls activities, specifying roles and responsibilities of all participants to the process.
- Provide a basic training course in using CAPITOLO software, in order to be able to read and understand progress and performance data.

3° course: advanced project controls

This course was addressed to project controls managers, project controls engineers and planners. This course had four main objectives:

- provide explanations of the project controls prescriptions;
- guarantee the full understanding of processes, organization and flow of information of the project control systems;

- provide an advanced training in planning and scheduling techniques, cost controls, as well as on earned value management and including a basic training on schedule delay analysis methods;
- provide advanced training in use of Primavera P6 and CAPITOLO.

3.5. PMO programme management office

The Consultant recommended and proposed the institution of a PMO (programme management office). The PMO had to act towards two directions: programme controls and company efficiency. The objectives of PMO were the following:

Programme management

- provide methodological support in project management;
- perform periodical evaluation of the programme progress and performance;
- guarantee communication through preparation of programme status reporting (internally, toward CEO and heads of departments and toward stakeholders).

Business efficiency

- set up and evolution of the policies and procedures of programme management;
- assuring continuing training of the project management resources;
- support HR in recruiting process.

4. Integrated project controls system

In essence, the scope of a project controls system is streamlining and enhancing the management decisions; the main capabilities can be summarized in four points:

a. providing a valid support in defining and developing the project baseline;
b. providing flexible and realistic means in measuring and assessing actual progress vs. planned baseline, by allowing an articulate analysis of the progress and performance achieved;
c. detecting and assessing as earliest as possible any possible event or situation which may impacts the progress of the project;
d. producing reports which could be obtained at different levels of details, tailored and customized to specific needs.

The core part of the PMS was the integrated project controls systems (PCS) based on *earned value management* (EVM), in order to provide an integrated control of time, costs, progress and performance analysis of the whole programme. The PCS is described hereafter through the:

1. project controls processes,
2. methodological model adopted,
3. organization (e.g. main roles and responsibilities) and
4. tools, in particular the EV software CAPITOLO.

4.1. project control processes

The following processes [1] are illustrated:

planning: developing baseline;
Progress control and performance evaluation;
Monitoring & reporting.

4.1.1. Planning: developing baseline

Baseline was defined through three key components: *scope, costs, time*. At the end of the planning process described below the *performance measurement baseline* [2] was set up.

Scope baseline

The scope of Quadrilatero programme was specified through a detailed WBS [3] developed by the Client with the assistance of the Consultant. The WBS of the sub-programme PIV (highways) was developed on the basis of the "final design" included in the contract packages for the two general design-build contractors.

The WBS of the sub-programme PAV (concessions) was developed on the basis of a preliminary feasibility study which allowed the identification of the location and type of the facilities (mall, factory, etc.) along the highways alignments. The WBS developed during planning stage was used as a *contractual WBS* and enclosed to the contract packages.

WBS were implemented through the Earned Value (EV) software (CAPITOLO) and, then transferred into Primavera P6. (Fig. 3)

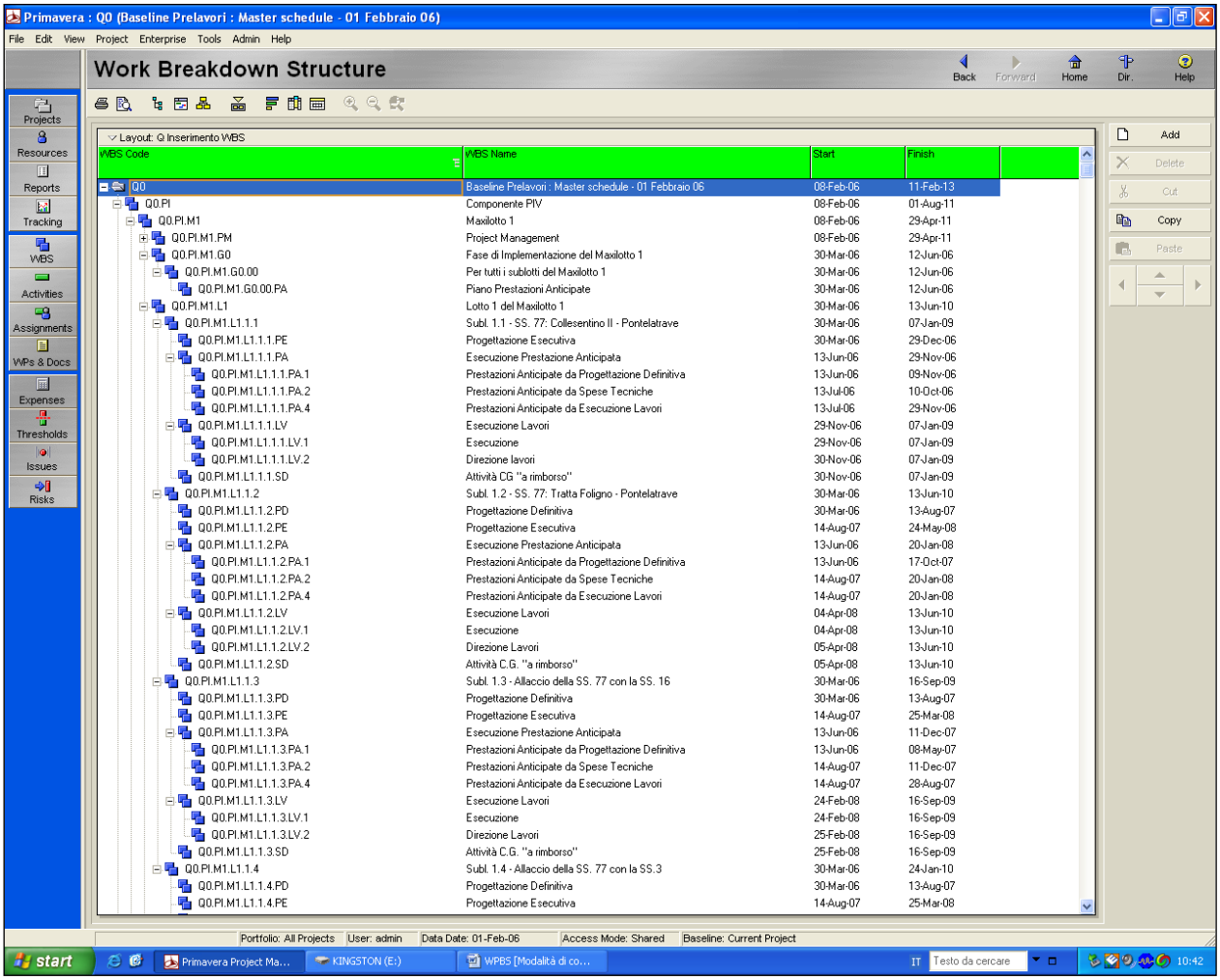

Fig. 3: WBS scheme

Cost baseline

The programme financial plan (budget cost and expenditures/funds plan) was structured accordingly to a CBS, which embedded the WBS. The CBS was developed to include specific *cost categories* accordingly to the legal framework for public works, which requires a standard codification of costs, (Tab. 1).

An OBS was also developed in order to specify the *control accounts* structure. The final purpose of the Consultant was to set up and implement a project controls system based on EVM, where the definition of control accounts was a fundamental step. (*See lesson learned 2*)

Each control account had a specific percentage value of the total lump-sum project price; the single control account was breakdown further into *work packages*, associated to specific *mechanism of progress* (e.g. earned value algorithms) described in next paragraph.
The CBS was implemented in EVM tool (CAPITOLO) (Fig. 4) described in par. 4.3.

CBS								DESCRIPTIONS
P	**I**	**M1**						**PROGRAMME 1**
P	I	M1	L1					LOT. 1
P	I	M1	L1	S1				SUB-LOT 1.1
P	**I**	**M1**	**L1**	**S1**	**A**		**A)**	**DESIGN-BUILD CONTRACTOR COSTS**
P	**I**	**M1**	**L1**	**S1**	**A1**			**DESIGN**
P	I	M1	L1	S1	A1	1		*Progettazione Definitiva (PD)*
P	I	M1	L1	S1	A1	2		*Progettazione Esecutiva (PE)*
P	**I**	**M1**	**L1**	**S1**	**A2**			**EARLY WORKS**
P	I	M1	L1	S1	A2	1		*Prestazioni anticipate da progettazione definitiva*
P	I	M1	L1	S1	A2	2		*Prestazione anticipate da spese tecniche*
P	I	M1	L1	S1	A2	3		*Prestazione anticipate da progettazione esecutiva*
P	I	M1	L1	S1	A2	4		*Prestazione anticipate da esecuzione lavori*
P	**I**	**M1**	**L1**	**S1**	**A3**			**WORKS**
P	I	M1	L1	S1	A3	1		*Esecuzione*
P	I	M1	L1	S1	A3	2		*Direzione lavori*
P	**I**	**M1**	**L1**	**S1**	**B**		**B)**	**OWNER COSTS**
P	**I**	**M1**	**L1**	**S1**	**B1**			**COST-PLUS ACTIVITIES**
P	I	M1	L1	S1	B1	1		*Interferenze*
P	I	M1	L1	S1	B1	2		*Acquisizione Aree ed Immobili (Espropri)*
P	I	M1	L1	S1	B1	3		*Allacciamenti ai pubblici servizi*
P	**I**	**M1**	**L1**	**S1**	**B2**			**MANAGEMENT RESERVE & CONTINGENCY**
P	I	M1	L1	S1	B2	1		*Imprevisti*
P	I	M1	L1	S1	B2	2		*Fondo di incentivazione art. 18 Legge 109/94*
P	I	M1	L1	S1	B2	3		*Collaudo (a tariffa, scontato del 20%, comprensivo degli oneri prev.)*
P	I	M1	L1	S1	B2	4		*Oneri per supporto Alta Sorveglianza (comprensivo di oneri previdenziali)*
P	I	M1	L1	S1	B2	5		*Oneri tecnico-amministrativi per la realizzazione del Quadrilatero*
P	I	M1	L1	S1	B2	6		*Per i Commissari di cui all'Art. 31/bis comma 1/bis della Legge 109/94 e smi*
P	I	M1	L1	S1	B2	7		*Spese per commissioni giudicatrici*

Tab. 1: CBS scheme (note that cost element labels of CBS are in Italian language)

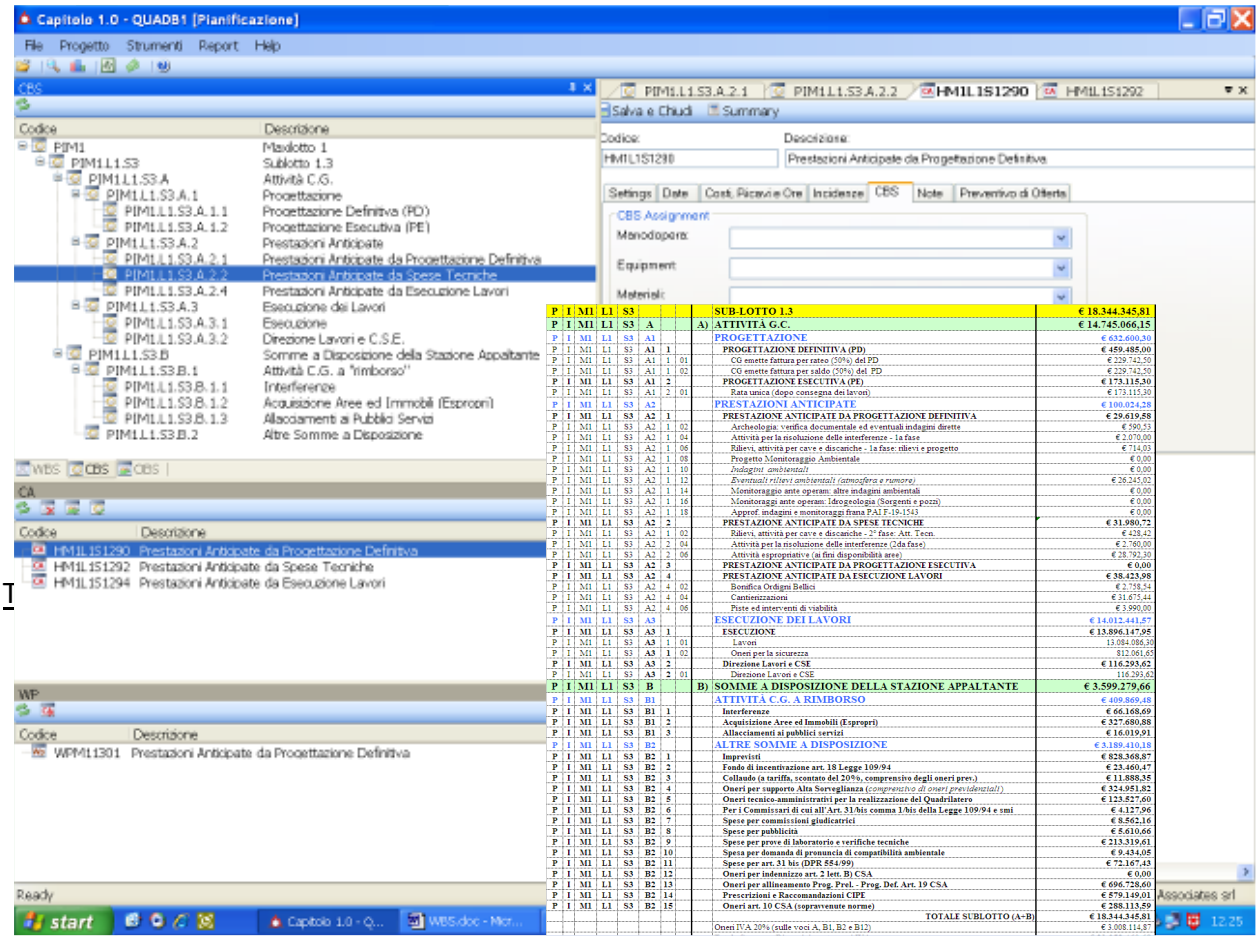

Fig. 4: CBS implemented into EV software CAPITOLO

Time baseline (master baseline schedule)

Planning and scheduling were carried out by the Client to develop a *programme master schedule* on the basis of WBS above described. The programme master schedule was developed by aggregation of three master project schedules regarding Lot 1 and 2 and a summary schedule of PAV programme (concessions).

For each of the two sub-programme there were *four levels of schedules* (the planning structures scheme is described fig. 7).

Lev. 1: milestones schedule;
Lev. 2: summary schedule (at control account level);
Lev. 3: CPM based schedule at work package level;
Lev. 4: task level was used to track progress of each work package; Lev 4 was also used also production biweekly schedule and used as tool to monitor production on site through weekly meeting with the general contractor. Finally, Lev 4 schedule was also used to plan the *quality controls on site* for specific works and activities, as planned by the quality

control plan. To be noted that assessing and certification of the actual dates of the activities pertaining the schedules, was a responsibility of quality inspectors, following criteria set up into the quality controls plans for various works. Similarly, the estimate of remaining duration of the schedules' activities was responsibility of construction supervisors of various disciplines, and approved by construction manager.

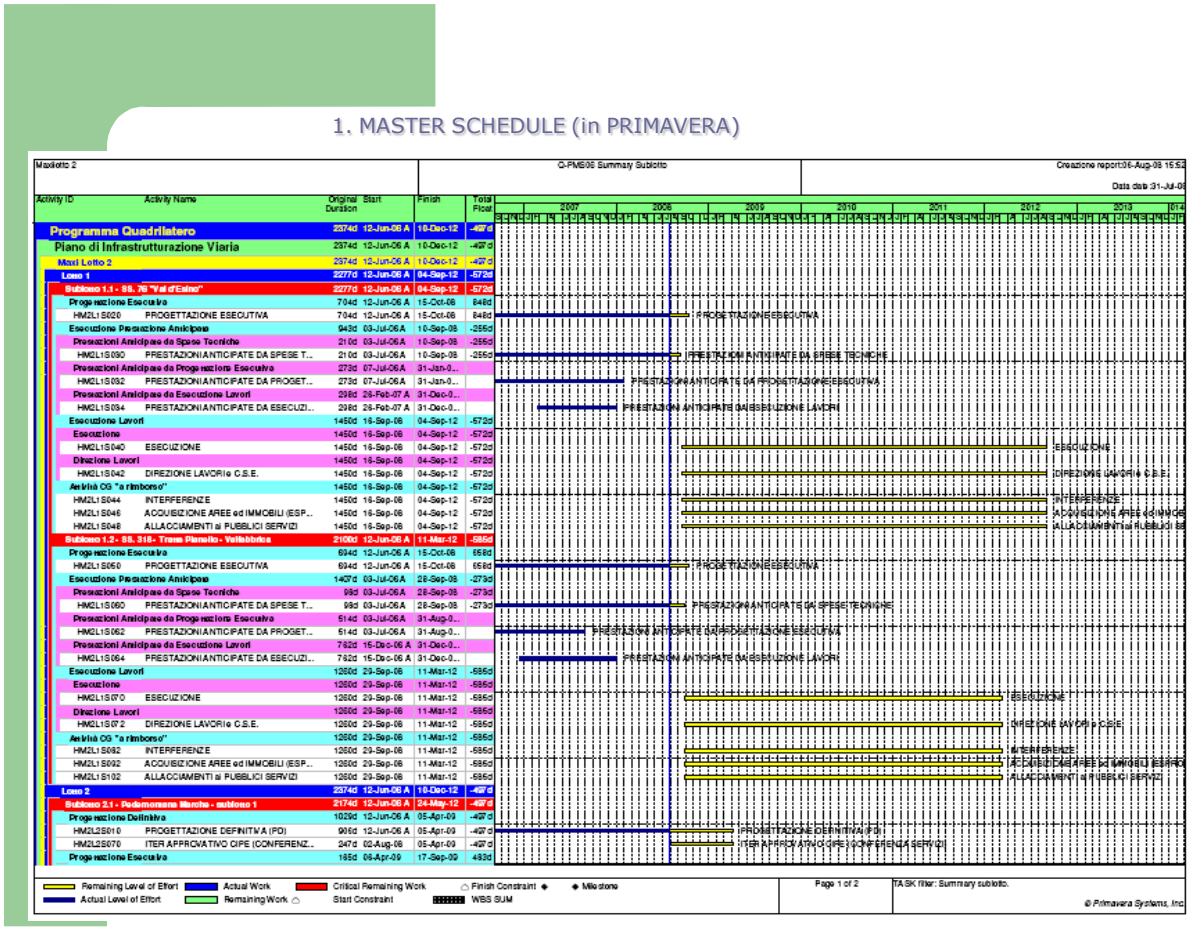

Fig. 5 Baseline schedule scheme in Primavera P6

4.1.2. Progress controls and performance evaluation

Integrated progress controls includes physical and cost progress measurement, [4], tracking and recording of data, CPM schedules updating [5] - [6], performance and productivity assessment, invoicing and payments. Further technical details are provided in the next two paragraphs. These processes involve all the parties committed to the projects' execution, on behalf of the Owner, as well as of the Contractors.

According to Italian regulations for public projects, in case of design-build contract, (though this form of contract is not exactly the same of the FIDIC or similar international contract), the following parties are involved:

- general contractor
- director of works
- high surveillance

"director of works" acts like a third party, under a contract relationship with the general contractor; "high surveillance" in another entity acting as an Owner's supervisor consultant.

These three parties are involved in the projects progress measurement and in the project management; each of those has specific responsibilities, specified by the legal framework for public works. This entails the development of accurate processes and coordination procedures, as well as a communication plan, in compliance with the existing regulations.

In summary, the progress data are gathered on site by the Contractor personnel, at the presence of director of works, who certifies the progress; then, the progress data are transmitted to the high surveillance, who verifies the data; high surveillance may ask a site inspection to assess the progress measurement, at the presence of director of works. (See lesson learned 3).
The progress data for construction works are based on actual quantities; they are gathered through specific pre-defined "progress forms" (generated directly by the EVM tool CAPITOLO), that must signed by director of works and high surveillance. The progress forms are then loaded into CAPITOLO by the Owner's project controls engineer on site.

Similarly, actual dates and remaining durations data of the schedules activities are gathered through specific pre-defined "scheduling update forms"; these data must be validated by Contractor's quality controls engineers, who certify the actual completion of the work packages; remaining durations forecast are estimated by construction inspectors of the various disciplines and validated by the Contractor's construction manager, then approved by director of works. The Contractor's project controls engineer on site proceeds to update the Primavera schedules; finally, the monthly schedule update is transmitted to the Owner's project controls on site, who transfers actual dates and remaining durations into CAPITOLO, by using a specify software interface.

The process described can be traced and it might be easily modelled by a modern document management system in order to digitalize the whole process.

4.1.3. Reporting and monitoring

Monitoring of the status of the whole programme was assured by a multilevel reporting structure, organized on four levels

1. Executive reporting, every quarter. It was an internal report addressed to top management of the employer's organization (Fig. 6).
2. Programme reporting, on monthly basis, regarding the status of two sub-programmes (PIV and PAV. Is was addressed to the Employer's project managers and used as main reference during the monthly progress meeting, at the presence of all the contractual parties;
3. Project reporting, on biweekly basis, regarding status of each sub-project (i.e. sub-lot of highways programme. It was addressed to site managers of High Surveillance.
4. Weekly production reporting: on weekly basis, it was addressed to operational teams on site and is used as main reference for weekly meetings between the parties.

Each reporting package included specific reports (narrative, schedules updates, charts and tabular reports).

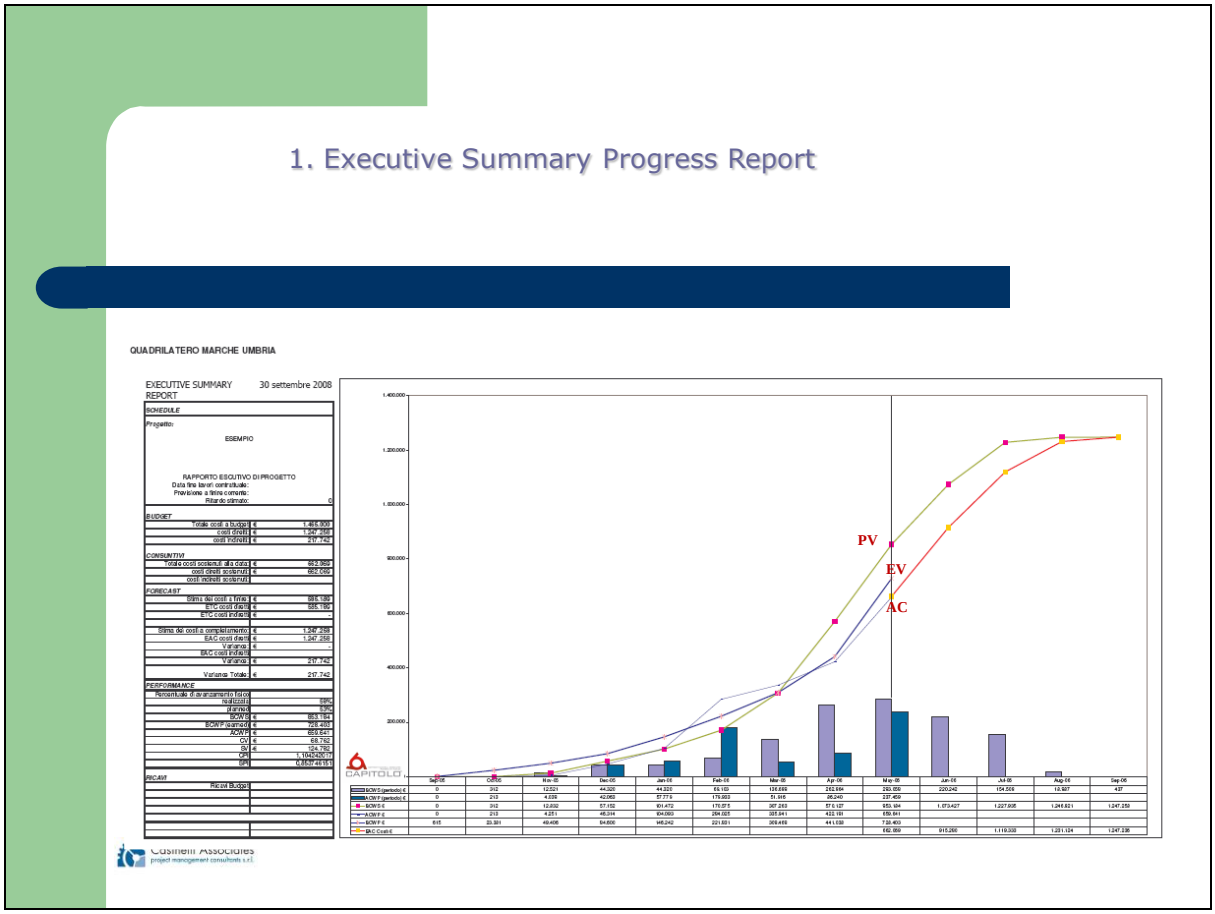

Fig. 6 scheme of the executive summary progress report based on EVM metrics

4.2. Organization of project controls (roles and responsibilities)

The team of programme controls of the Client was based on the following roles:

- Programme controls manager (located at head quarter office)
- Project controls manager Lot1 Highways Project (at main site of Lot 1)
- Project controls manager Lot 2 Highways Project (at main site of Lot 2)
- Project controls for the single projects regarding the concessions.

The main duty of the project controls on site was to guarantee the proper process of project progress measurement, as ruled by the project controls procedures and project controls prescriptions described in par. 3.2

4.3. Methodological model and EVM tool CAPITOLO

The package CAPITOLO has been designed by the author and implemented on the PMS project; CAPITOLO allows the implementation of complex control structures (WBS/CBS/OBS and Control Account) and the use of EVM metrics (PV, EV, AC, CV, SV, SPI and CPI) at any level of details; the software tool also allows to use different algorithms for progress measurements which can be used through customized progress measurement forms; this capability did facilitate the implementation of the progress measurement and payment procedures, letting to have a paper copy of the documents with the needed signatures. The process might be certainly digitalized by using advanced documents controls systems.

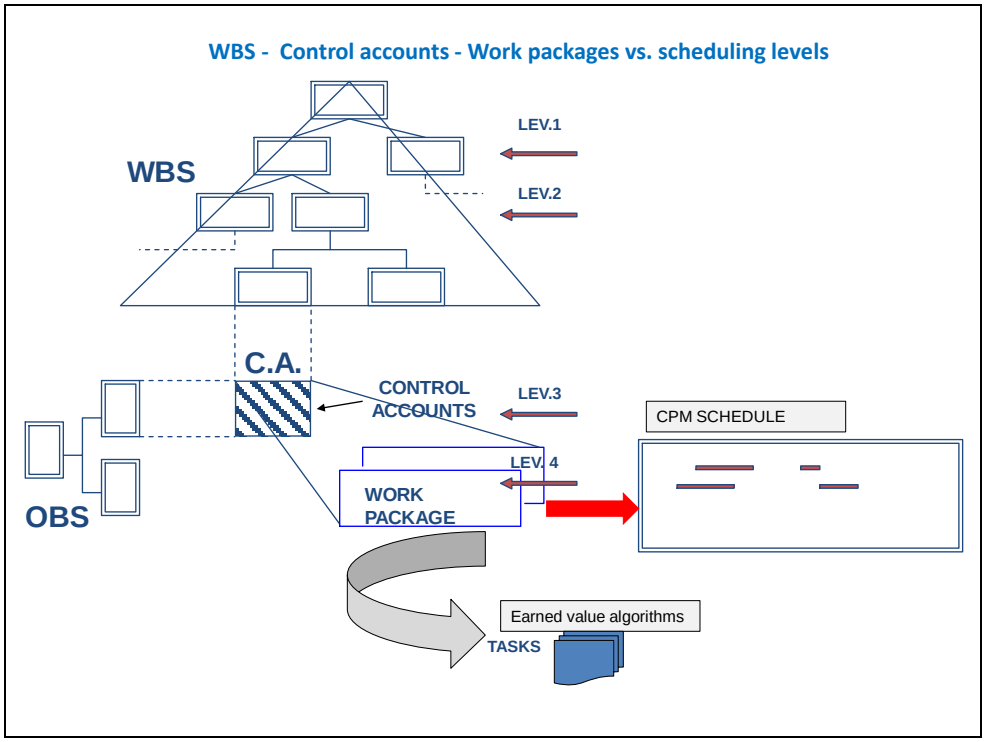

Fig. 7: scheme of methodological model

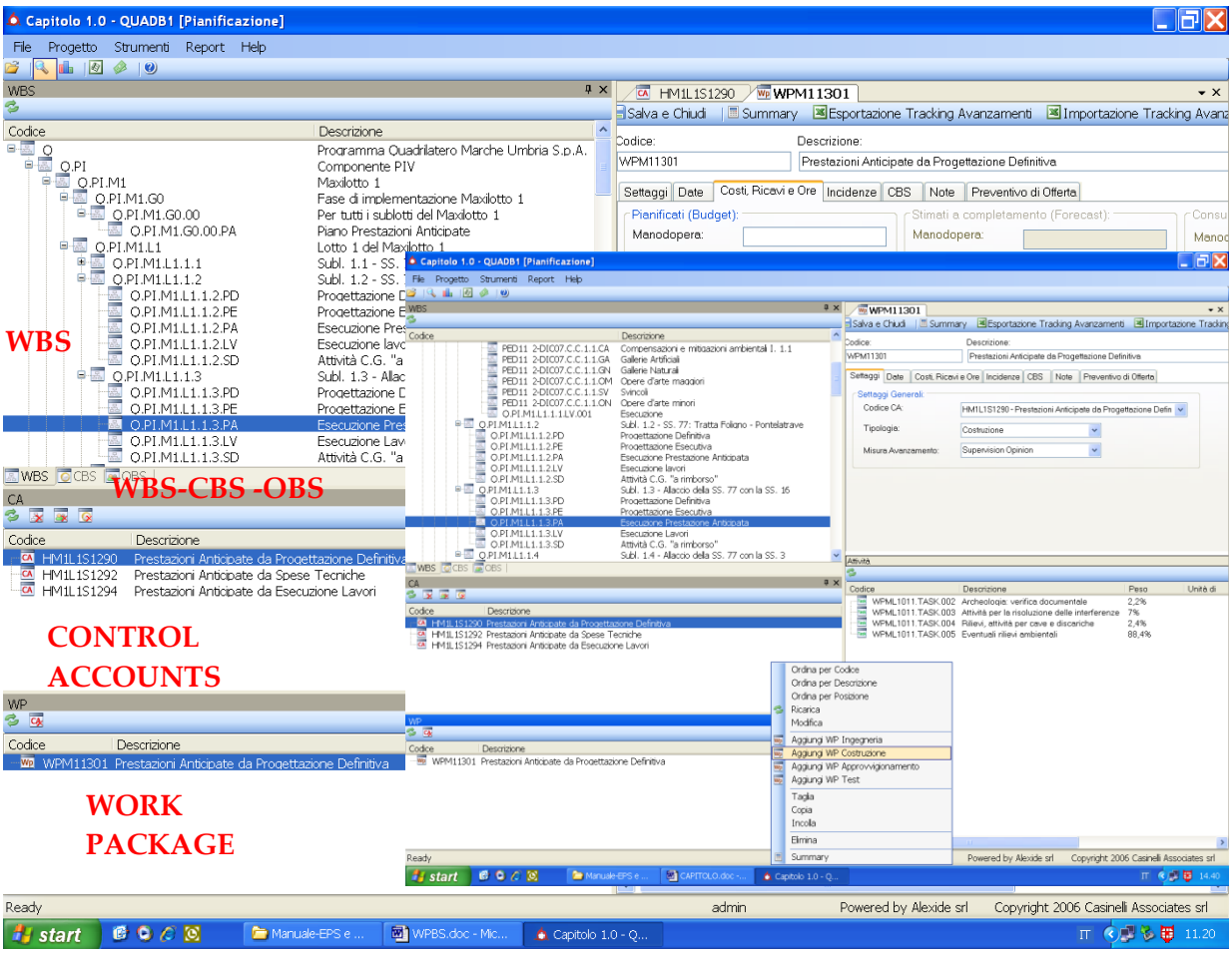

Fig. 8: EVM project modeling

The physical progress is assessed through earned value algorithms relevant to the specific work packages (design, procurement, construction, testing); CAPITOLO allows the use of the following algorithms to calculate progress:

- Method 1: Unit completed (quantities)
- Method 2: Incremental milestones
- Method 3: Start/ Finish (0%-100% or 0%-50%-100% or other options)
- Method 4: Supervision Opinion (level of effort)
- Method 5: Weighted or Equivalent Units

Project progress data are collected at *work package level* through pre-defined progress forms generated directly by the software; "actual dates" and "remaining durations" data, pertaining schedules, are read by CAPITOLO directly from Primavera and transferred into the system via a specific interface. The progress data are then aggregated by WBS, OBS, CBS and Control Accounts, to provide usual EV metrics:

- AC: actual cost;
- EV: earned value;

- PV: planned value;
- CV: cost variance
- SV: schedule variance
- SPI: schedule percent index
- CPI: cost percent index.

The above parameters are calculated by CAPITOLO at any level of detail of the control structures, allowing a reading of the "performance" from different point of views and at different level of detail (for example to monitor the performance of a specific sub-contractor, or the status of the works of a specific bridge, as well as the status of detailed design, etc.). (See lesson learned 4)

The software allows handling costs as well as revenues and implementing articulated and multiple project progress "weightage" structures. Costs can be modelled accordingly to specific categories: (equipment, manpower, material, subcontracts); these capabilities help the contractors to perform cost controls and progress measurement for invoicing (Fig.9 and 10).

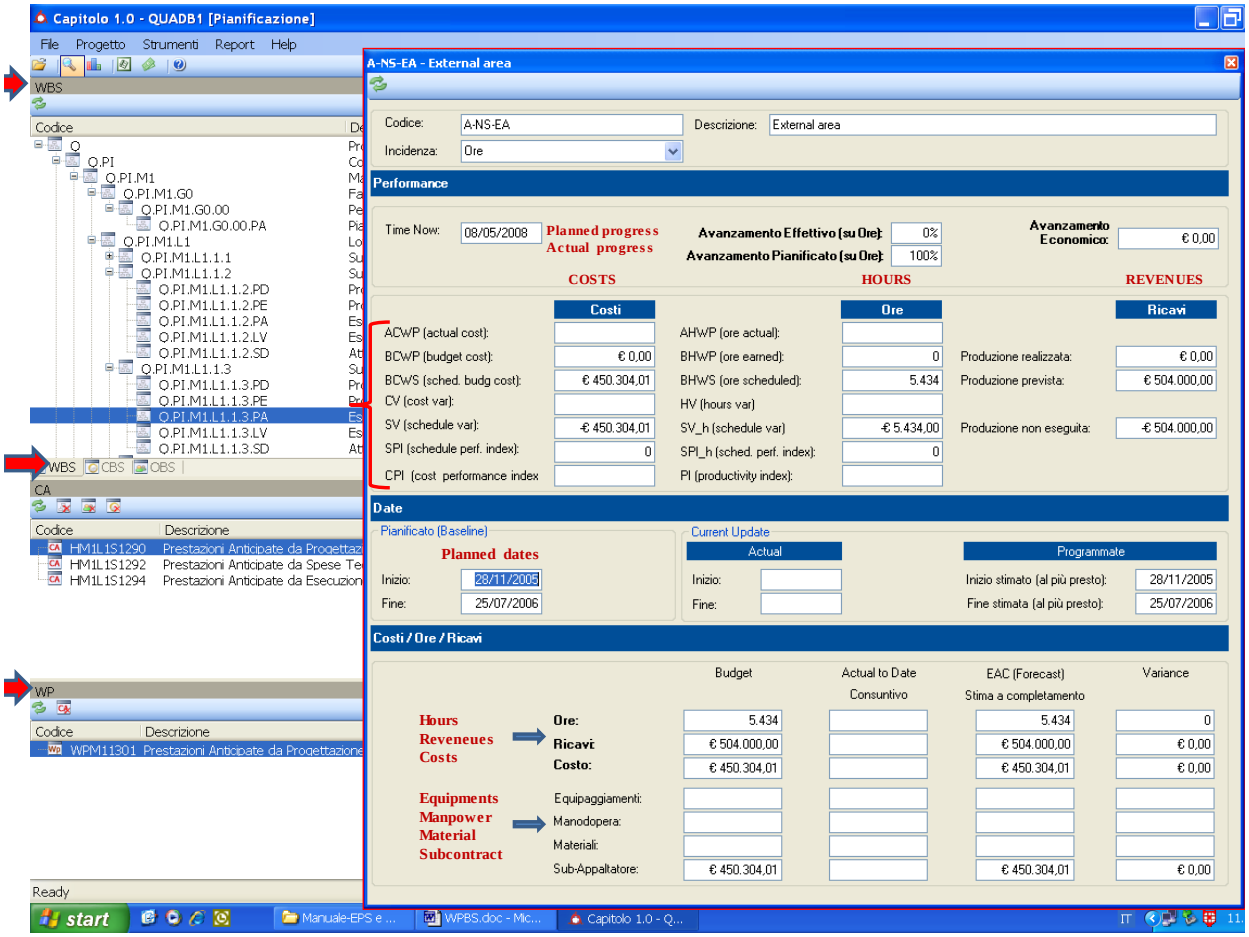

Fig. 9 Earned value metrics for project status evaluation

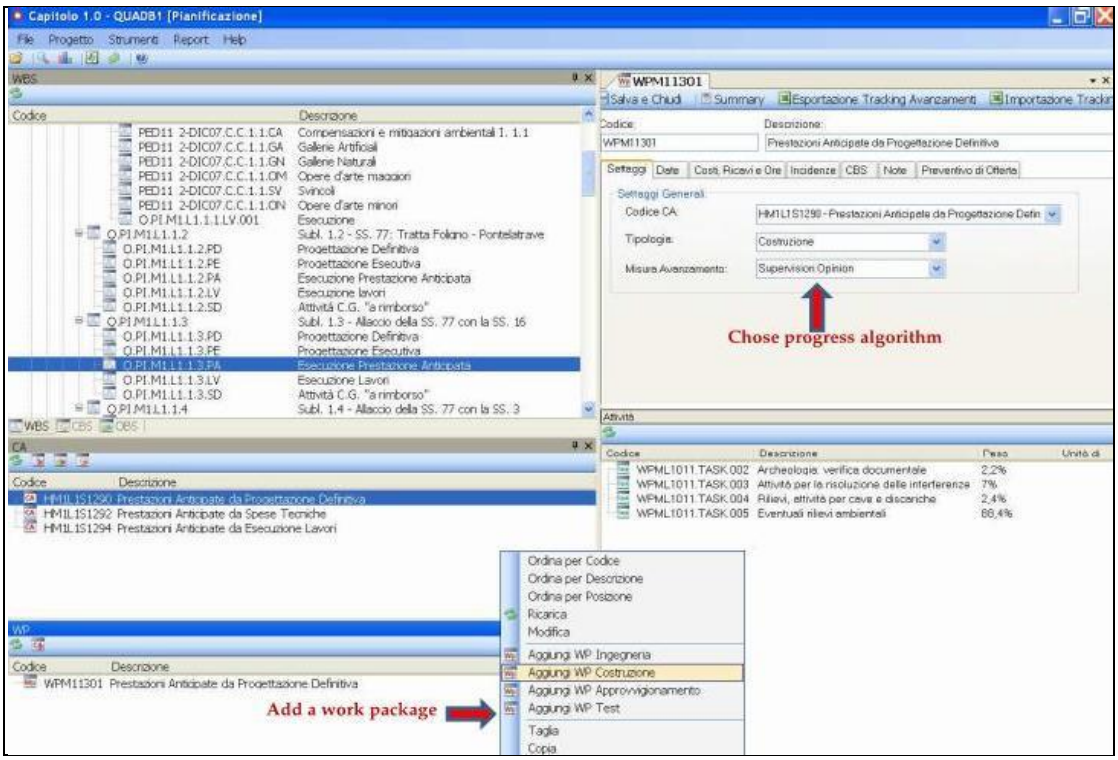

Fig. 10 Adding work package and choosing earned value algorithm

Progress data aggregated by CBS are transferred to the company's ERP for budgeting and financial controls; the data are used by a financial model (ECO-FIN) to generate the financial information and data for expenditures plans, funds management and other financial reports.

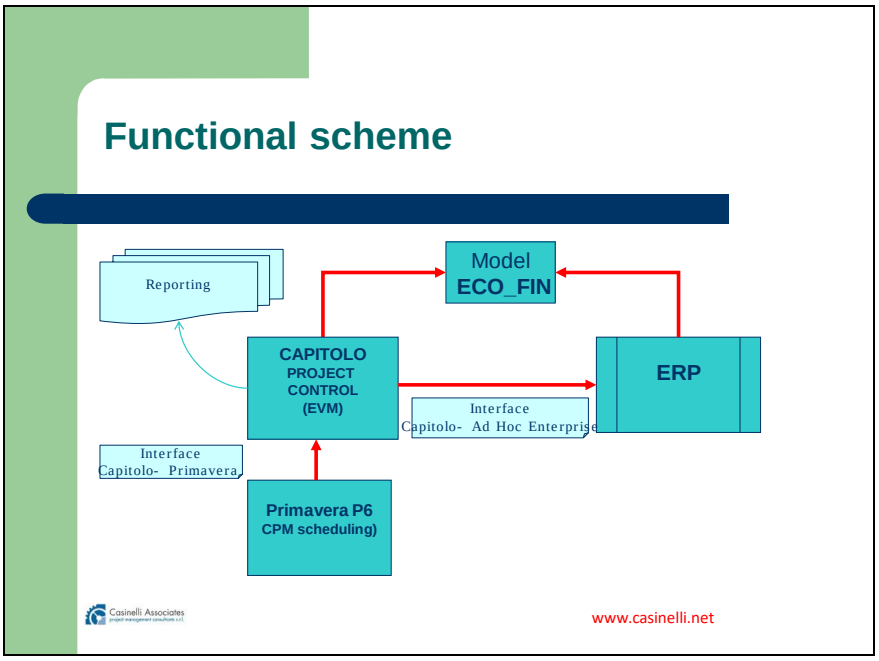

Fig. 11 Functional scheme of project and financial control process.

5. Lessons learned

Lesson learned 1: coordination procedures

The lack of a contractual requirement for *coordination procedures* between the Client and the Consultant was an issue which was not been properly evaluated at the tender stage. In a consulting project, a Scope of works not described in sufficient detail, combined with a lack of a coordination procedure ruling the process of review-approval of contractual deliverables, becomes a risk factor which might become detrimental for the project success. As matter of fact, invoicing is usually linked to the achievements of specific delivery of the various packages (i.e. deliverables). In similar projects the review-approval procedure should be planned by the Client as a mandatory "first deliverable" and this should be clearly specified in the tender documents; even better, the Client should develop a proper procedure in the pre-planning stage and impose it on the tender documents to avoid frictions between Client and Consultant which might detriment relationships and cause delays during the project's start-up phase.

Lesson learned 2: utilizing control accounts concept

The discussion with Client around the benefits of using *control accounts* was more difficult than expected; while earned value is a concept known, much less awareness and knowledge exists about the logic process (i.e. the general process model) which is required to implement earned value management systems (EVMS) that was ultimately the final scope of the Consultant. Although there was a training programme, already described, a cycle of workshops on earned value methodology should be planned and carried out at earliest stage of a consultancy project targeted to introduce an integrated PCS.

Lesson learned 3: the importance of procedures and contractual prescriptions

Managing programme, sub programmes and subprojects, as well as gathering, aggregating and *consolidating actual dates and progress data* from several entities (i.e. contractors and subcontractor) involved in a large programme are certainly critical issues for project controls. In such contexts EVM can be implemented only through a well-designed framework of contractual prescriptions and procedures.

Lesson learned 4: managing remaining durations in Primavera P6

Estimating remaining durations in scheduling is a critical process which requires a procedure. Estimating remaining durations of work packages/tasks in progress should be ruled and agreed between the parties; for example, estimating should be based on productivity tracked on site; assessment of the estimating of remaining durations should be a process involving also supervisors specialists as well as quality controls inspectors on site; however such as estimates should be approved by the construction manager and assessed in the progress report. In addition, "automatic" scheduling routines (auto-progress or similar shortcuts) should be

specifically forbidden through the project controls prescriptions, as well as other scheduling "techniques" for float suppressing. Also, the use of LAGs in the logic linkages should be limited and, when used, always described and commented in the narrative progress report. These "techniques" might alter the logic, hence, the individuation of the critical and sub-critical paths. The above issues should be carefully addressed though project controls prescriptions and monitored by project controls personnel especially during the initial stage of project execution.

6. Conclusions

In essence, the scope of a project controls system is streamlining and enhancing the management decisions; the main capabilities can be summarized in four points:

a. Providing valid support in defining and developing the project baseline;
b. Providing flexible and realistic means for measuring and assessing actual progress vs. planned baseline, by allowing an articulate analysis of the progress and performance achieved;
c. Detecting and assessing as earliest as possible any possible event or situation which may impact the progress of the project;
d. Producing reports which could be obtained at different levels of details, tailored and customized to specific needs.

EVM is the most effective methodology to support project controls and to implement an integrated project controls system. In real application, especially on large size projects, it is necessary a preliminary study of the project and its context, as well as of the contract model, in order to design the project controls system in all its components: organization, processes modeling, contractual and procedural framework (i.e. project controls prescriptions and project controls procedures), which must be integrated with the whole set of project management and governance procedures.

The earned value software tool should be powerful to allow the implementation of earned value metrics across articulated controls structures (WBS, OBS, CBS and Control Accounts) as well as flexible enough to allow a customization of multiple earned value algorithms for project progress measurement and the production of tailored reports.

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