Survey and comparison of the project management softwares used by engineering, procurement and construction companies

LORENZO DAMIANI, ROBERTO REVETRIA, IVA SVILENOVA, PIETRO GIRIBONE

DIME
University of Genoa
Via Montallegro 1 16145 Genoa
ITALY
Lorenzo.Damiani@unige.it; Roberto.Revetria@unige.it; Giribone@itim.unige.it

Abstract: - This paper presents a survey and comparison of a series of project management softwares used by engineering, procurement and construction companies in order to evaluate the best software tools based on chosen features. The evaluation was carried out through the well known Analytic Hierarchy Process (AHP) method. After a brief description of the features required by a project management tool and after a brief description of the software tools in exam, the authors applied the AHP method to the softwares cross-evaluating each of their features.

Key-Words: -EPC, Plant Construction .

1 Introduction

Project management is the process and activity of planning, organizing, motivating, and controlling resources, procedures and protocols to achieve specific goals in scientific or daily problems. A project is a temporary endeavor designed to produce a unique product, service or result with a defined beginning and end (usually time-constrained, and often constrained by funding or deliverables) undertaken to meet unique goals and objectives, typically to bring about beneficial change or added value.[1][2] The temporary nature of projects stands in contrast with business as usual (or operations),[3] which are repetitive, permanent, or semi-permanent functional activities to produce products or services. In practice, the management of these two systems is often quite different, and as such requires the development of distinct technical skills and management strategies.[4]

The primary challenge of project management is to achieve all of the project goals[5] and objectives while honoring the preconceived constraints.[6] The primary constraints are scope, time, quality and budget.[7] The secondary — and more ambitious — challenge is to optimize the allocation of necessary inputs and integrate them to meet pre-defined objectives.

This article talks about Engineering, Procurement and Construction (EPC) Projects and how the organizations are executing these projects using modern techniques and effective management.

If present organizations want to compete in today's turbulent market, they will need to become more adaptive, fast and collaborative, and use information technology systems (IT) [1,2]. This is especially evident in the engineering, procurement and construction (EPC) industry where delivering projects within boundaries of the iron triangle: time, cost, and quality, is more than just signing the contract and waiting for the project objectives to be achieved by themselves [3,4]. For successful Project Management (PM), an efficient supporting infrastructure must be implemented as well [5,6,7]. Furthermore, IT is now routinely used in the construction industry as a tool for reducing issues generated by fragmentation [7].

The execution phase of industrial projects such as oil and gas projects consists of detailed engineering, procurement and construction, normally known as EPC and starts after final investment decision by the owners. Companies who provide an integrated engineering, procurement and construction services are called EPC contractors. Managing the EPC contracts are usually complicated and require special expertise and knowledge and software tools.

ISBN: 978-1-61804-338-2

Project Management fundamentals are changing due to business [8] and technological forces [9]. Market globalization and international mergers are increasing the need for partnerships across organizational, cultural, and national boundaries. IT advancements have made collaboration in distributed modes possible, technologies like Group Support Systems (GSS) and videoconferencing enable people to collaborate across dispersed geographical areas. The trend toward business globalization and the advancement of IT has given rise to new organizational forms called 'virtual organizations' [10, 11, 12]. Both traditional organizations and virtual organizations may employ 'virtual projects' involving team members from different geographical sites, organizations and cultures [13]. The challenge of virtual PM is supporting collaboration among the people working at different sites, different times or in different organizations.

Collaboration can consume a significant amount of project workers' time. As more companies and industries move toward electronic commerce and digital business a large percentage of projects involve software development. "Studies of co-located development teams in large (software) projects have shown that up to 70% of developer's time is spent collaborating [14], and 85% of project costs can be accounted for by team activities [15]"

PM must consider different project aspects. PM can be defined as 'a special way of organizing, planning and controlling to create defined changes or products with predictable cost, time and quality' [16]. PM thus involves managing financial issues, risks, resources, schedules, quality, and processes. Each of these areas must be managed well for a project to be successful, however process management plays a more important role in a multi-site projects, because it involves task identification, task allocation, task tracking and reporting.

Good PM can provide team members and other stakeholders with a clear overview of who is doing what, and the status of a specific task. Visibility of project progress is a critical factor for project success [17] In fact, there are so many tools at this point that it can be difficult to choose between them. The tool that best fits a particular project manager will depend on their individual requirements, and those requirements will change based on each manager's style and the project at hand. However, it is still beneficial to look at what other project managers find important. Once a manager knows their requirements, it is time to decide which software will meet them. In order to do that they must research the types of tools that exist.

Therefore, a study was necessary in order to identify technical and managerial information about the usage of PMS in the construction industry and to help the industry to become more successful in implementing and choosing PMS and consequently managing projects. The main objective of this paper is to analyze the current PMS in construction industry and compare the main feautures. It analyses the most popular PMS used.Furthermore, the paper identifies a listing of the top processes that the construction industry uses the PMS for bringing the project in to success.

2 Research methodology

In order to compare the softwares is used the analytic hierarchy process (AHP), developed by Thomas L. Saaty in the 1970s. AHP is a multi-criteria technique for decision support which allows to compare more alternatives in relation to a plurality of criteria, of qualitative or quantitative type, and derive a global evaluation for each of them. This allows to:

- order the alternatives according to a preference axis;
- individuate the best alternative;
- assign the alternatives to predefined sub-groups.

AHP provides a distinction between the subjective component of the evaluation and the objective data. The decider individuates an ensemble of evaluation criteria of the n decisional alternatives and assigns to each criterion a weight in percentage; after that, he assigns a score which is the impact of the criterion on the decision. The score of each decisional alternative is the weighted average of the scores of each criterion on the decision for the weight assigned to each criterion. The criteria are compared in couples, assigning a score of relative importance one the other. The sum of the weights must be 100%. The score of each criterion is obtained summing what is obtained with respect to all the others. The scores obtained are usually normalized, subtracting the average and dividing each weight for the standard deviation.

Comparing tools is not a simple operation. Each tool is designed to fulfill a particular function and may not compare exactly with another. Therefore, anyone who wants to compare different packages must first create a rubric by which tools can be measured. While the criteria may change slightly for

each manager's search, it is possible to speak to enough of them to create a generic scheme that can be helpful to all.

Rather than prescribing a "correct" decision, the AHP will help the companies to find one that best suits their project and their needs. It provides a comprehensive and rational framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions.

In our research we will define the areas the elements' relative meaning and importance and will discuss their importance for achieving a successful project management. We are going to make survey on 13 project management softwares used by engineering and construction companies.

Once the hierarchy is built, the decision will be made by systematically evaluating its various elements by comparing them to one another two at a time, with respect to their impact on an element above them in the hierarchy. It is the essence of the AHP that human judgments, and not just the underlying information, can be used in performing the evaluations.

The AHP converts these evaluations to numerical values that can be processed and compared over the entire range of the problem. A numerical weight or priority is derived for each element of the hierarchy, allowing diverse and often incommensurable elements to be compared to one another in a rational and consistent way. This capability distinguishes the AHP from other decision making techniques.

In the final step of the process, numerical priorities are calculated for each of the decision alternatives. In this research is used a web base AHP Calculator [18].These numbers represent the alternatives' relative ability to achieve the decision goal, so they allow a straightforward consideration of the various courses of action.

3 Literature research

3.1 Collaborative project management

Turner [18] defines a project as '*an endeavor in which human, material and financial resources are organized in a novel way, to undertake a unique scope of work, of given specification, with constraints of cost and time, so as to achieve beneficial change defined by quantitative and qualitative objectives.*' The aim of PM is to produce the required deliverables within the constraints of time and budget. Without efficient and effective project management, projects risk schedule and budget overruns or even cancellation. 31% of new IS projects are canceled before completion at an estimated total cost of $81 billion[19].

3.2 Issue tracking

In a perfect world all projects would go directly according to plan, but this is not a perfect world, so delays can crop up for any number of reasons, errors occur, and all sorts of issues can arise, which is why you need a project management system that tracks all issues and ensures that they get resolved in a timely manner. An issue tracking system (also ITS, trouble ticket system, support ticket, request management or incident ticket system) is a computer software package that manages and maintains lists of issues, as needed by an organization.

Track Issues with ease in meeting notes, and daily field reports, then watch as items are checked off the list in the Issues Log. Issue tracking includes also Punchlist.

3.3 Scheduling

One major change of PM in the last 25 years is the use of computerized project planning and control methods [16]. PM software packages are available to provide Gantt charts, PERT diagrams, resource histograms, and project status tracking. There are many factors to manage for a project, and project managers cannot pay equal attention to each factor, therefore they prioritize factors and decide which ones to pay the most attention to. Evaristo and Fenema [11] point out that traditional PM emphasizes management of a single project at a single location, and the key issue is scheduling. This might be why people often think about Gantt Charts and PERT diagrams when they think about PM. People manage project inputs, resources, delivery of products, and people, but seldom manage the work or process of the project [20].

3.4 Resource management

Resource management is a key element to activity resource estimating and project human resource management. Both are essential components of a comprehensive project management plan to execute and monitor a project successfully [20][21]. As is the case with the larger discipline of project management, there are resource management software tools available that automate and assist the process of resource allocation to projects and portfolio resource transparency including supply and demand of resources. The goal of these tools typically is to ensure that: (i) there are employees within our organization with required

specific skill set and desired profile required for a project, (ii) decide the number and skill sets of new employees to hire, and (iii) allocate the workforce to various projects.

3.5 Documents management

A document management system (DMS) is a system (based on computer programs in the case of the management of digital documents) used to track, manage and store documents

Along with the managerial purposes, the PMS can also serve as a quality management system. Thus, it can act as an enabler of the PM and IS improvement and as such, it plays an integral part in managements of the construction projects.

The degree and level of detail to which the document defines how and what work will be performed and what work will be excluded can determine how well the project management team can control the overall project development in term of planning, managing and controlling the execution. The project detailed description should illustrate directly or by reference to other documents: - project objectives such as measurable success criteria that could include costs, schedule and quality targets; - product scope description; - project requirements describing conditions or capabilities that must be met or possessed by the deliverables of the project to satisfy a contract, standard, specification or other formally imposed documents; - stakeholder analyses of all stakeholder needs, wants, and expectations translated into prioritized documents; - project boundaries that state explicitly what is excluded from the project; - project deliverables including both the outputs that comprise the product or service of the project, as well as ancillary results, such as project management reports and documentation; - project constraints that limit team's options such as contractually provisions or any imposed date or predefined budget; - project assumptions and their potential impact if they prove to be false; - initial defined risks; - initial organization; - fund limitations.

3.6 Workflow management

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

3.7 Reporting and analysis

There is some difference between monitoring and controlling activities.

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

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

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

Summing up, the monitoring and controlling process consists of: • monitoring the ongoing project activities against the project management plan and the project performance baseline; • influencing the factors that could circumvent integrated change control so only approved changes are implemented. This continuous monitoring provides the project team insight into the health of the project and highlights any area that require additional attention.

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

4.8 Budget management

For cost control on a project, the construction plan and the associated cash flow estimates can provide the baseline reference for subsequent project monitoring and control. For schedules, progress on individual activities and the achievement of milestone completions can be

compared with the project schedule to monitor the progress of activities. Contract and job specifications provide the criteria by which to assess and assure the required quality of construction. The final or detailed cost estimate provides a baseline for the assessment of financial performance during the project. To the extent that costs are within the detailed cost estimate, then the project is thought to be under financial control. Overruns in particular cost categories signal the possibility of problems and give an indication of exactly what problems are being encountered. Expense oriented construction planning and control focuses upon the categories included in the final cost estimation. This focus is particular relevant for projects with few activities and considerable repetition such as grading and paving roadways.

4.9 Invoicing

The accounted costs figures include the sum of the cost already registered in the accounting system. As far as these figures are entered in a legacy system their accuracy is 100%. Accounted costs are the basis for the assessment of the actual costs. The invoiced cost figures are the costs already certified and registered. They refer to activities or work packages finished in the previous phase of the project and they are collected with a 100% accuracy.

4 Description of the softwares

In this section, a brief overview of the softwares analyzed is provided.

ClickHomes

ClickHome is an application, an Online tool and application service provider for project management and electronic construction collaboration developed by Imagemation - an Australian Software development company based in Morley, founded in 2001. ClickHomes combines Microsoft and iOS technologies to build a customizable, Residential Construction Solution.

DynaRoad

DynaRoad is a project management software for heavy civil engineering projects. It is used for planning the mass haul of an earthworks project, creating a construction schedule, and monitoring the progress of the project.

The software has a Windows graphical user interface and it includes views such as the Gantt chart, resource graph, mass haul diagram, map view, time distance chart and text reports. The time-location method has strengths compared to Gantt charts and traditional scheduling. The map view indicates live tasks at any moment using different colors. For cut and fill operations, a haul plan based on quantities, bulking factors, possible haul routes and production rates can be calculated automatically.

EcoSys

EcoSys EPC is fast becoming the global software standard for the project controls industry. A web-based platform, EPC provides the deepest capabilities to support the complete spectrum of solutions within the Project Controls discipline – from project portfolio management and capital program management, through budgeting, forecasting, and performance reporting.

EcoSys EPC is an easy-to-use, web-based software platform designed to provide full lifecycle project controls in a single system.

EasyPlant

EasyPlant is a proprietary software owned by the EPC company Technip. It is an IT tool aimed to manage and follow up all the activities involved during project lifecycle

Starting from early works, going through Construction and Pre-commissioning / Commissioning up to the Start-Up of the Plant, it allows to keep under control all activities related to Quality Control, HSE, Hydro Testing, Progress achievement, Punch Listing and so on.

Ganttic

Ganttic (from Gantt charts[) is a web-based proprietary project management software for organizations focusing on resource scheduling and project planning. It is used for manufacturing, engineering, construction and project-based services such as design agencies and architects. Ganttic offers 3 pricing options.

The product is distributed as software as a service.

Primavera

Since 1983 the Primavera Systems (http://www.oracle.com) have been developing their PMS package for construction and today it has become a leading provider of the Project Portfolio Management (PPM) solutions for the construction industry. Primavera is suitable for project-oriented and mature companies that one can mainly find in developed countries. However, Primavera can rarely be found in the transitional economies. Furthermore, while Primavera was once mostly used to handle large and complex projects, today it is also used for many projects valued at under $100 000.

ISBN: 978-1-61804-338-2

Planner Suite

Planner Suite is a project and portfolio management software developed in Delphi from CodeGear using DataSnap-technology. It includes features such as WBS[1] Scheduling, Gantt Schedule, Time and progress tracking, Utilisation optimization, Portfolio overview, Resource allocation, Document management, Cost estimation, Expense management, Authorization, Invoicing, Earned Value and reports.

Proliance

Proliance software improves capital project and facility performance, by streamlining the plan-build-operate lifecycle. Proliance is designed for Owner and Owner-agent organizations managing capital planning, building, and renovation processes across large infrastructure programs. Leading organizations rely on Proliance for planning and controlling cost, scope and schedule on their projects and programs, with best of breed capabilities on a platform adaptable across capital-intensive industries, including.

Prolog

Prolog Software provides complete Construction Project Management.Prolog software is the leading construction project management solution for contractors and other AEC firms, providing a complete system of record for managing project information, from the field to the back office. Designed by construction professionals for construction professionals, Prolog is built for project managers accountable for construction costs, scope and schedules, and for project teams responsible for the successful delivery of projects.

Sigep

The system has been developed on top of Eni's Project Management System, named SIGEP, and it has been configured to fit the internal workflows and procedures that have been designed for the Goliat project.

The system provides a framework where all project information (schedule, progress, costs, changes, interface issues, etc) can be cross referenced with each other, as well as to the main project control structures (Work Breakdown Structure, Product Breakdown Structure), therefore enforcing a consistent view of the project status from different perspectives. Moreover, the integrations of the system with SAP, Primaveraand the Intergraphengineering database.

SmartSheets

Smartsheet is an online project management, productivity and team collaboration software as a service application based in Bellevue, Washington. Its online project management tool works like a familiar spreadsheet, but with additional functionality including cloud-capabilities for sharing, attachments, integration with file storage services and Gantt charts.

SmartPlant

SmartPlant Enterprise is a comprehensive product suite offering increasing value from IT in order to improve project execution, handover, and plant operational efficiency. You can learn more about the products that make up the SmartPlant Enterprise solution and how our customers are using them to increase their productivity and profitability by reading the latest issue of Insight Magazine online.

Its modular architecture provides scalability, enabling clients to start small and later grow in harmony with their specific business needs to create substantial return on investment while reducing risk.

Spider Project

Spider Project is a project management software, developed by a Russian company, Spider Project Team.Spider Project is powerful professional project management software, unparalleled in the world market. Spider Project offers numerous unique functional features and is the only PM software that optimizes resource, cost, and material constrained schedules and budgets for projects and portfolios.

4 Develpoment of the evaluation matrix

The following table includes the project management softwares used by the engineering and construction companies. They will serve as base for our comparison. In the comparison will not take part the software that fulfill all criteria.

Each software will be compared with the other in accordance to each already discussed systems. It is used YES/NO model which will allow us easily to distinguish the difference between the softwares. The comparison table is shown in Figure 1.

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Software	Collaborative software	Issue tracking system	Scheduling	Resource Management	Document Management	Workflow system	Reporting and Analyses	Budget Management	Invoicing
ClickHome	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No
DynaRoad	No	No	Yes	Yes	No	Yes	Yes	No	No
EcoSys	Yes	No	Yes	Yes	No	Yes	Yes	Yes	No
Easy Plant	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes
Ganttic	Yes	No	Yes	Yes	No	No	No	No	No
Oracle Primavera EPPM (Primavera P6)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Planner Suite	No	No	Yes	Yes	Yes	No	No	No	Yes
Proliance	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Prolog	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
SIGEP	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Smartsheet	Yes	Yes	No	Yes	Yes	No	Yes	No	No
SmartPlant	Yes	No	Yes	Yes	No	Yes	Yes	No	No
Spider Project	No	No	Yes	Yes	No	No	Yes	Yes	Yes

Figure 1: Evaluation table.

Priorities

Each category is evaluated according to the importance of each based in the previous part of the research.

The resulting weights are based on the principal eigenvector of the decision matrix

These are the resulting weights for the criteria based on pairwise comparisons.

Category		Priority	Rank
1	Collaborative software	**0.176**	**2**
2	Issue tracking system	**0.027**	**7**
3	Scheduling	**0.225**	**1**
4	Resource Management	**0.153**	**5**
5	Document Management	**0.064**	**6**
6	Workflow System	**0.02**	**8**
7	Reporting and Analyses	**0.153**	**4**
8	Budget Manageent	**0.166**	**3**
9	Invoicing	**0.017**	**9**

¤	1¤	2¤	3¤	4¤	5¤	6¤	7¤	8¤	9¤	¤
1¤	1¤	6.00¤	1.00¤	1.00¤	7.00¤	7.00¤	1.00¤	1.00¤	7.00¤	¤
2¤	0.17¤	1¤	0.20¤	0.20¤	1.00¤	1.00¤	0.11¤	0.11¤	1.00¤	¤
3¤	1.00¤	5.00¤	1¤	3.00¤	9.00¤	9.00¤	1.00¤	1.00¤	9.00¤	¤
4¤	1.00¤	5.00¤	0.33¤	1¤	5.00¤	9.00¤	1.00¤	1.00¤	9.00¤	¤
5¤	0.14¤	1.00¤	0.11¤	0.20¤	1¤	5.00¤	1.00¤	0.33¤	9.00¤	¤
6¤	0.14¤	1.00¤	0.11¤	0.11¤	0.20¤	1¤	0.11¤	0.11¤	2.00¤	¤
7¤	1.00¤	9.00¤	1.00¤	1.00¤	1.00¤	9.00¤	1¤	1.00¤	9.00¤	¤
8¤	1.00¤	9.00¤	1.00¤	1.00¤	3.00¤	9.00¤	1.00¤	1¤	9.00¤	¤
9¤	0.14¤	1.00¤	0.11¤	0.11¤	0.11¤	0.50¤	0.11¤	0.11¤	1¤	¤

Number of comparisons = 36 Consistency Ratio CR = 7.4%

4 Conclusion

Based on the evaluation that we have made in this research with an eye to the most important functions in project management software which are scheduling, collaboration, budgeting and reporting.

The results of the research show that Primavera is the most proper software to be used. Of course Primavera is the most frequent PMS used in the construction industry. Primavera is followed by EcoSys and Spider Pojects with great priority in scheduling, collaboration and budgeting.

EcoSys excels in three areas: it delivers the ability to perform best practice project cost controls directly within the system. However, most organizations have good data in multiple systems. As such, EPC was designed to serve as a world-class integration platform as well, facilitating the creation of a “single version of the truth” that encompasses data from schedules, cost actuals, commitments and contracts, timesheets, and more. With that data, EcoSys EPC leverages its built-in reporting engine to provide automated, real-time reports and dashboards, controlled by end users rather than a reliance on IT or outside consultants.

Collaboration can consume a significant amount of project workers’ time. As more companies and industries move toward electronic commerce and digital business a large percentage of projects involve software development.

Despite the deep planning and cost control capabilities, EcoSys EPC is easy-to-use. It leverages an Excel-like interface, but runs on a database with full business rule enforcement, audit trail, and role-based security. The system’s configurability allows customers to tailor spreadsheets, formulas, reports and even terminology to create the best possible fit for an organization’s specific industry and internal needs.

ISBN: 978-1-61804-338-2

Project scheduling in Spider Project includes all traditional methods (like CPM and renewable resource leveling) and adds Quantity based scheduling (when activity durations are calculated basing on activity work volumes (physical quantities) and assigned resource productivities), Skill scheduling (when the software selects which resources to assign basing on their skills, productivities, costs and user defined priorities), Conditional scheduling (when software selects one of competing network paths basing on user defined conditions on special switch activities).

In Spider Project users can create any number of Cost Components (e.g. salary, overheads, cost of materials, cost of machines, external services, etc.) and Cost Centers (groups of cost components), assign Parallel Costs to the same activities (e.g. internal cost, contract cost) and calculate Parallel Budgets, simulate financing, apply Cost Discounting, manage Cash Flows and calculate NPV, IRR and Payback Periods.

Costs can be assigned to activities, resources, resource assignments, materials as fixed, per work hour and per work volume units. Any number of currencies may be used.

Project and Portfolio schedules are calculated taking into account financial restrictions delaying activity execution until its completion is financed.

For further research might be interesting for the future users adding the price for buying the software and use of more detailed fundamental scale in assigning the weights of each criteria to the companies.

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