Universidade do Minho
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The use of software tools for project management – focus on collaborative management

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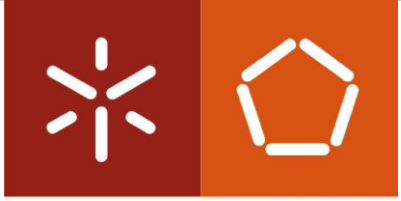

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The use of software tools for project management – focus on collaborative management

Dissertação de Mestrado
Mestrado em Engenharia Industrial

Trabalho efetuado sob a orientação da
Professora Doutora Anabela Pereira Tereso

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ABSTRACT

Today, projects involve members from different geographical areas more than any other time in history. Thus, adequate Collaborative Project Management Software (CollabPMS) solutions are needed to enable individuals and organizations to manage, communicate and work together across time and space barriers.

This dissertation describes a set of managerial and collaborative functionalities that a CollabPMS should provide to support the complexities of a distributed project effectively. Out of hundreds of software packages available in the market, four were selected, ProjectLibre, Redmine, Microsoft Project Professional 2013 and Clarizen, to assess whether they had or not functionalities that we described.

Clarizen can be considered the best software for managing distributed projects, because it provides, by default, all the required managerial functionalities and the collaborative features that support the coordinated collaboration level. ProjectLibre was the software that less stood out in this evaluation, because although it provides the majority of the outlined managerial functionalities it doesn't support any level of collaboration.

Keywords: Project Management, Software, Distributed Projects, Collaboration

RESUMO

Hoje, os projetos envolvem membros de diferentes áreas geográficas mais do que em qualquer outro momento da história. Assim sendo, são necessárias soluções adequadas de software colaborativo de gestão de projectos para permitir que indivíduos e organizações giram, comuniquem e trabalhem em conjunto ultrapassando as barreiras do tempo e do espaço.

Esta dissertação descreve um conjunto de funcionalidades de gestão e de colaboração que um software colaborativo de gestão de projectos deve ter para apoiar as complexidades de um projeto distribuído de forma eficaz. Das centenas de pacotes de software disponíveis no mercado, quatro foram selecionados, ProjectLibre, Redmine, Microsoft Project Profissional 2013 e Clarizen, para avaliar se eles tinham ou não as funcionalidades que descrevemos.

Clarizen pode ser considerado o melhor software para gerir projetos distribuídos, porque fornece, por defeito, todas as funcionalidades de gestão requeridas e todas as funções de colaboração que suportam o nível de colaboração coordenado. ProjectLibre foi o software que menos se destacou nesta avaliação, porque, embora forneça a maioria das funcionalidades de gestão delineadas, não suporta qualquer nível de colaboração.

PALAVRAS-CHAVE: Gestão de Projectos, Software, Projectos Distribuídos, Colaboração

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ABBREVIATIONS

CollabPM: Collaborative Project management

CollabPMS: Collaborative project management software

CPM: Critical Path Method

CVS: Comma Separated Values

GSS: Group Support System

MPP: Microsoft Project Professional

PC: Personal computer

PERT: Program Evaluation and Review Technique

PLC: Project life cycle

PMS: Project Management Software

TSV: Tab Separated Value

XML: Extensible Markup Language

WBS: Work Breakdown Structure

1. INTRODUCTION

1.1. Background

In the past of project management, projects were typically developed at a single location (Evaristo & Fenema, 1999). However, due to business globalization and technology advancements, a new type of projects called distributed projects have arisen involving project collaborators from different geographical locations and organizations. As the number of distributed projects increases and the project management shifts towards a more collaborative approach, the project management software designed to support the projects at a single location is becoming inadequate (Chen, Romano, & Nunamaker, 2006). To handle projects involving scattered teams, the project managers should rely on a specific kind of project management software called Collaborative Project Management Software (CollabPMS) (Chen, Nunamaker, & Romano, 2002).

Choosing a project management software in theory sounds simple, but as there are hundreds of different project management software packages rich in functionalities, selecting one in practice may be very difficult. Furthermore, not each and every software package is suitable to deal with distributed projects, thus, the users must spend much of their time analyzing which software package better fits its particular project management needs (Conlin & Retik, 1997; Liberatore & Pollack-Johnson, 2003).

In the last decade few researchers as Romano et al. (2002) and Chen et al. (2006) had roughly defined a conceptual CollabPMS architecture. One of their research gaps was not defining specifically which functionalities a CollabPMS should have to handle distributed projects. In this dissertation we attempt to fill this gap by proposing a set of specific managerial functionalities that a CollabPMS should have to support an efficient management of distributed projects. Because distributed projects requires high degrees of collaboration among team members to successfully achieve the project's goal, this dissertation also describes which functionalities a CollabPMS should have to support the different levels of collaboration.

Furthermore, by selecting four software packages available in the market was possible to judge their capability to handle distributed projects. For that, it was evaluated whether they have

or not the managerial and collaborative functionalities that we outlined as ideal to support the complexities of a distributed project effectively.

The work developed under this dissertation may help project managers to understand which functionalities they should be looking for on a CollabPMS to effectively conduct projects with scattered team members. Moreover, software developers can also use this work to foresee which functionalities they should incorporate on future CollabPMS.

1.2. Goals

This work aims to:

1. Analyze and compare, at the conceptual level, the collaborative project management paradigm and the traditional project management paradigm.
2. Explore the importance of software tools for project management.
3. Describe which managerial and collaborative functionalities a CollabPMS should provide to support the complexities of a distributed project effectively.
4. Testing a software package by using a project example.
5. Analyze whether the selected software packages have or not the managerial and collaborative functionalities that we outlined as ideal to handle distributed projects.
6. Classify the selected software packages according to the collaboration level they support.

1.3. Research Strategy

The choice of the research strategies directly depends upon the particular goals of this dissertation.

Therefore, to answer to the dissertation's goals - numbers 1, 2, 3, 5, 6 (section 1.2), we employed the archival research strategy. The archival research is based on seeking out and

extract evidence from recorded facts and thus there is no direct observation of the facts, all the data is examined ex post facto by the researcher (Buckley, 1976).

Archival research makes use of administrative records and documents as the principal source of data (Saunders, Thornhill, & Lewis, 2009). Primary archival research is based on original archival records as historical documents and the secondary archival research is based on journals, ledgers etc. (Buckley, 1976). Within this dissertation we made use of secondary archival research, that is, we used as source of data, scientific papers, books and websites.

To fulfill the goal number 4 (section 1.2), that is, testing a software package by using a project example, we considered the experiment as a research strategy. Experiment is conducting a test to verifying or refuting a hypothesis (Saunders et al., 2009).This research methodology allows direct access to the facts, the researcher either experiences the phenomena or is an eye-witness to the events (Buckley, 1976).

1.4. Dissertation´s Overall Outline

This dissertation was organized in a way that shows the natural progression of the work, and it was divided in eight main sections:

- **Section 1: Introduction**

This section introduces the background of this research and its objectives. It also exposes the research strategies that were adopted and the dissertation´s overall outline.

- **Section 2: Project Management**

Describes the basic concepts of project management, namely what is a project, project life cycle and what is project management. These basic concepts are essential to understanding the core work of this dissertation. Furthermore, this section also presents an historical perspective and the benefits of using project management.

- **Section 3: Collaborative Project Management**

At this point, some of the problems associated with traditional project management are revised and explained why collaborative project management is the adequate approach to deal with distributed projects.

- **Section 4: Software tools for project management**

Bringing together the subjects software tools and project management, section 4 explains why project management software is vital to manage projects. A particular kind of project management software called CollabPMS is also presented here. Some of the available software packages on the market are shown at the end of the section.

- **Section 5: Project example**

One of the aims of this dissertation was to test a software package by using a project example. Within this purpose, a project example of the construction of a new plant for a major manufacturer was considered. This section describes in depth the project in question.

- **Section 6: Analysis of Project Management Software Packages**

This section is divided in two subsections. The subsection 6.1 describes the managerial functionalities that a CollabPMS should have to support an efficient management of distributed projects. Furthermore, using the project example of previous section, it was possible to test the ProjectLibre software and further assess whether it has or hasn´t the managerial functionalities outlined to perform efficient project management. The same evaluation was performed on the software packages Redmine, Microsoft Project Professional 2013 (MPP 2013) and Clarizen.

The subsection 6.2 defines which collaborative functionalities a CollabPMS should provide to successfully support dispersed teams. Moreover, this subsection classifies all the selected software packages according to the collaboration level that they support.

- **Section 7: Discussion**

Based on the framework of functionalities that was proposed, it is discussed whether the selected software packages are suitable or not to handle efficiently distributed projects.

- **Section 8: Conclusions and Future Research**

The section 8 closes the research work developed under this dissertation and suggests what should be the next steps of this research project.

2. PROJECT MANAGEMENT

2.1. What is a Project?

An enormous variety of projects can be found nowadays in our society, coming in various sizes and types. Traditionally, large scale projects are from water, energy, transport, and telecommunications industries. These large size projects often require huge work teams and the collaboration of several sponsoring organizations. However, the projects with which most people are involved at work are smaller. Projects at work may include engineering or construction projects to build a warehouse or an apartment complex, implementation of new technologies, development and product launches. Also, advertising campaigns, global mergers, capital acquisitions, organizing the local church event, are often handled as small projects (Turner, 2008).

The Project Management Institute, a worldwide leading non-profit professional association in the area of project management, has defined a project as a temporary endeavor undertaken to produce a unique product, service, or result (Project Management Institute, 2008). In other words, whether a project is large or small scale, a project is an endeavour in which human, financial, and material resources are specifically organized, to undertake a clearly defined scope of work in a planned period of time. Once the project is complete, something unique has been produced, for example, a new house was built (Heagney, 2012).

Projects can also be viewed in terms of their attributes:

- **Defined start and end dates**

A project must have a beginning and ending date defined in the planned phase. Many projects need to begin on a specific date and the date of conclusion is estimated. Some projects have a fixed completion date, and in this case, it is necessary to work backwards to determine the date at which the project must start. Because the project is planned to be developed within a

specific time period, it has a temporary existence, generally being disbanded when project goals are achieved (Tonchia, 2008).

- **A clearly defined scope**

The project's goal must be clearly identified and agreed upon between the project stakeholders, this is, between project manager, project team members and client, since the client's level of satisfaction will directly be influenced by the accomplishment of the project goal. Furthermore, a project must have a clear goal to drive its development and the team towards the right direction (Kliem & Ludin, 1992).

- **Multiple resources**

Resources provide the means for achieving the project's goal. People, money and materials are the most used resources in a project. To carry out a project, human resources are compulsory, no project can be planned and executed without human input. Furthermore, human resources and the materials has an associated cost, there is the need to pay salaries and the materials itself, which call for financial resources (Heldman, 2003).

- **Uniqueness**

There is a distinct difference between projects and operations inside an organization. Operations are everyday work, performed over and over again: it's just about routine. These operations don't have a specific end, they are basically ongoing work. For instance, when a company produces daily chocolate drops we are talking about ongoing operations. However, when the same company wants to develop a new candy it's about a project that we are talking. Ultimately, the project of the new candy will end up by being assimilated into the ongoing operations of the company. Because projects are originated to bring a product or service that didn't exist before, a project is a unique entity. Moreover, the combination of time, place, people and budget is unique for every project. Therefore, projects cannot be managed adequately by the managerial routines that are used in the daily work: they require another type of management (Meredith & Mantel, 2008; Reiss, 1995).

2.2. Project Life Cycle

The Project Life Cycle (PLC) is a collection of logical phases that map the life of a project from its beginning to its end (Marchewka, 2003). Although, there are several PLC models (Meredith & Mantel, 2008; Prince, 2009; Project Management Institute, 2008) projects must go generally through 5 phases: Define Project Goal, Plan Project, Execute Project Plan, Close Project and Evaluate Project (Figure 1).

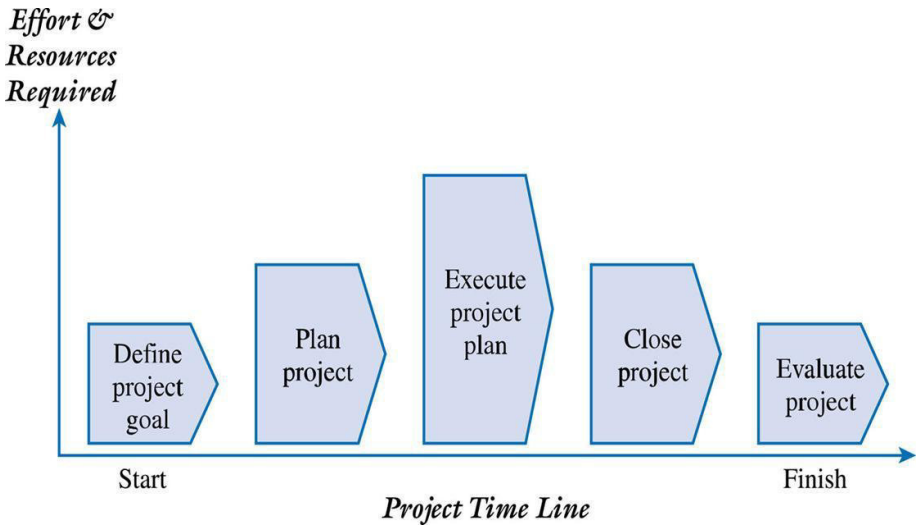


Figure 1: A Generic Project Life Cycle (Marchewka, 2003)

Every phase of the PLC has its own features and the output of each phase serves as an input for the following phase. The project manager is the person who is mainly in charge for managing the entire project and a clear understanding of these five phases helps organize the work and allocate and control properly the resources (Jurison, 1999).

The efforts/resources, in terms of cost and staffing levels, are generally low at the start of the project, but increase as the project's work is being done, then decreases at the end as the project is being concluded (Figure 1) (Marchewka, 2003).

In the following paragraphs, the PLC phases will be described:

- **Phase 1 - Define Project Goal**

Defining the overall goal of the project should be the first step in every project. In this phase, the client and the project development team should define clearly the project´s goal. If the team does not agree on the goal, or if the client's needs are not correctly understood before starting the work, the project is likely to fail. Moreover, a well-defined goal serves as a reference during the project (Heagney, 2012).

- **Phase 2 - Plan Project**

Project planning is the heart of the PLC. It determines how the project's work will be accomplished. In this phase, all the deliverables, task durations and its dependencies, resources and costs must be defined. The plan produced during this phase is called baseline plan and is the convergence of the schedule, resources assignment and project budget (Levine, 2002).

One of the most important duties of the planning phase is defining the relationships between the project tasks. The relationships between the tasks are called dependencies. By default, the relationship between tasks is a finish-to-start (F-S) dependency, that is, task B can´t start until task A is finished. However, other dependencies are possible: if task B can start 3 days after task A starts, this is designated as a start-to-start (S-S) dependency. When the completion of an activity determines the completion of another, it is designated as a finish-to-finish (F-F) dependency, for instance, the task B can finish 5 days after the completion of task A. The less common task dependency is the start-to-finish (S-F) dependency, which is the exact opposite of an F-S dependency. Thus, an S-F relationship means that task A cannot end until task B starts.

At the end of this phase, the plan of the project will be used as a tool to monitor the project's performance throughout its life cycle (Heldman, 2003).

- **Phase 3 - Execute Project Plan**

In this phase of the PLC, teams are assembled, the tasks assigned and the work carried out. As the execution of the project progresses, schedule, budget and people must be actively managed to ensure that the plan outlined in the planning phase is accomplished.

If the execution of the project doesn't take place as originally planned, corrective actions should be taken to get the project back on track. This means that it might be required to revisit the project planning phase in order to plan the corrective actions and then put them into place. The project's progress must be documented and communicated to all of the project's stakeholders. The executing phase is where most of the project resources are utilized and most of the budget is spent. At the end of this phase, the project's final product is complete (Jurison, 1999; Marchewka, 2003).

- **Phase 4 - Close Project**

The closure of the project should include a final project report and a presentation to the client to communicate that all their requests have been completed as specified (Heldman, 2003).

- **Phase 5 - Evaluate Project**

This is the last phase of the PLC. The project team should document the lessons learned and subsequently share them throughout the organization. Many of these lessons learned can be translated into best practices and integrated into future projects. In addition, at the end of the project, the behavior of the project team should be evaluated together with the project's performance (Marchewka, 2003).

2.3. What is project management?

As organizations have recognized how critical projects are to their success, more and more organizations have embraced project management as a key strategy for remaining competitive in today's highly demanding business environment (Kerzner, 2001). The use of project management is widespread in all kinds of businesses, for example, the automotive industry uses mandatorily project management to develop new automobiles. Big companies as General Electric and Pratt & Whitney, use project management to develop new jet aircraft engines. Furthermore, the adoption of project management techniques by construction companies has been very noticeable. Companies of the tertiary sector, such as marketing and consulting companies, have

all made use of project management. In general, businesses regularly use project management to accomplish unique outcomes with limited resources under critical time constraints (Meredith & Mantel, 2008).

According to the definition of the Project Management Institute (2008), project management is the application of knowledge, skills, tools and techniques to project activities to meet the project requirements. For Heldman (2003), project management is essentially the process of planning, executing, monitoring and controlling project's results to reach the project's purpose and thus guarantee the client's satisfaction.

Project management is a formal discipline for managing projects. Managing a project typically includes addressing the needs and expectations of the project stakeholders as the project is planned and developed, as well as identifying the requirements of the project and balancing the project constraints (Heagney, 2012; Kerzner, 2001; Newton, 2006). In project management, it is necessary to manage tasks and available resources to achieve the project's objective within a defined budget and within a limited time (Atkinson, 1999; Reiss, 1995). Thus, a successful project management includes compulsory managing time, costs and human resources during the project's progress. In project management, the project manager is the main responsible for defining the project plan and for managing the project's risks. Moreover, the project manager anticipates and assesses risks and then handles them when they arise (Heagney, 2012). The project manager is also responsible for understanding the interdependencies among people and assigned tasks for each team member as well as supervising their work and motivating them to execute the plan.

2.4. Historical perspective

Project management as a concept goes back to a long time ago. History reveals that mega projects as Egyptian pyramids or Roman aqueducts were managed very similarly to today´s projects. These ancient projects had requirements, designs and constraints, and also depended on communication, decision making and logical thought as projects nowadays. In addition, these antique projects also had, as projects nowadays, a schedule, a budget, a customer and had to combine the works of different people into a singular coherent whole to meet the project

requirements and accomplish the project´s goal. Furthermore, project managers today and the creators of pyramids and aqueducts have played similar roles in each respective era, they formed a plan and applied the technology, tools and knowledge available, to solve problems and achieve the project's purpose (Berkun, 2005).

Although there has been some form of project management since early civilization, a number of authors like Crawford et al. (2006) and Howes (2001) trace the intellectual roots of modern project management to the 1950s. Modern project management has begun with the development of two networks analysis techniques, namely the Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT). The CPM was developed by DuPont Corporation and Remington Rand Corporation in 1957 to study the planning and management of construction work for chemical plants. Around the same period, the United States Navy, aiming to manage a submarine missile program, created a similar technique called PERT. Both mathematical techniques - CPM and PERT are very useful for scheduling a project since they allow to calculate the project's critical path (Hillier & Lieberman, 2010; Howes, 2001; Pich, Loch, & Meyer, 2002; Söderlund, 2004).

Not less important is the contribution to project management history by the famous Henry Gantt (1861 –1919) who invented the Gantt chart in 1917 and Henri Fayol (1841-1925) who proposed the five functions of management. Both are considered the forerunners of modern project management (Morris, 1997).

If we look to the recent history of project management, economic conditions were one of the factors that most influenced the history of project management. Before the world economic recession of 1989–1993, corporate managers in general, believed that their guidance was sufficient to keep their companies healthy and competitively strong. They looked at project management as a very complex thing which required much time to implement. Nevertheless, when companies accepted the implementation of project management, it simply consisted of using scheduling tools for the benefit of the employee but not of the company. During the economic crisis, the development and accomplishment of projects were very slow, turning the company into less competitive. As a consequence, managers became aware that they were not fully prepared to address an economic recession. Therefore, senior managers understood that to be truly successful in management, projects must have a repeatable process predicated upon speed and quality of execution (Kerzner, 2001). By the end of the recession, in 1993, most

companies had at last recognized the huge importance of project management and its benefits. Senior managers finally realized that the principles of project management could promote the successful implementation of any type of project.

The historical perspective of project management allows us to understand that there are thousands of years of project experience to learn from.

2.5. Benefits of project management

Company competitiveness is closely linked to the ability of the company to manage successful product development projects. Managers got the conscious that they should have a more proactive role in the management of projects and their outcome, rather than confine its role just to the management of routine operations. A winning strategy and consequently a winning company look at project management as a competitive tool. Technology can be effortlessly imitated, however, it is more difficult to imitate the way companies manage projects, which means that most of a company success depends literally on the success of project management (Munns & Bjeirmi, 1996; Tonchia, 2008). Furthermore, project management is the only feasible way to accomplish certain goals, for example, it is not possible to design and build a major weapon system in a timely and economically acceptable manner without totally manage the PLC (Meredith & Mantel, 2008).

The majority of organizations indicate that through project management they have experienced several benefits as (Heldman, 2003; Phillips & Luckey, 2006):

- Better customer relations
- A tight control of the project results and an efficient application of the resources
- Reduction of time to complete projects
- Higher quality and consistency of the projects
- Lower development costs and higher profit margins
- A sharper orientation - project management assures that both the project manager and the team are headed in the right destination
- Better leadership and interdepartmental coordination
- Higher work morale of the project team

- Reduction of project risks, identification and correction of problems at an early date
- Improvement of communications
- Provision of standard methodologies for everyone in the organization to follow
- Ensured consistency in reporting

In short, project management improves the overall project's performance, it centers on the serious business of getting work done on time and within budget while meeting the customer's expectations. Hence, the stronger the emphasis on achieving results inside an organization, the more likely the organization will implement project management (Heldman, 2003).

2.6. Collaborative project management

The traditional project management is the paradigm that focuses on management of a single project at a single location (Chen et al., 2002).

Over the past two decades, the economic globalization and market dynamics have been increasing the need for business partnerships and projects across nations. Therefore, these "new" generation of projects called distributed projects can require project collaborators from different geographical locations, organizations and cultural backgrounds (Rad & Levin, 2003). Because distributed projects are characterized by its team distribution across space and time, issues like negotiation of the project goals, scheduling, task allocation, task interdependence, parallel working on the same task and resource sharing, require a high degree of collaboration among team members (Evaristo & Fenema, 1999). Thanks to the advances in computer networks and collaborative information systems, collaboration among dispersed people can now be effectively implemented (Helbrough, 1995; Nunamaker, Romano, & Briggs, 2001).

As collaboration has become an important part of project management, the traditional project management paradigm has been shifting towards a more Collaborative Project Management (CollabPM) paradigm (Chen et al., 2002).

In the following paragraphs, some common problems associated with traditional project management paradigm will be described. Moreover it will be also explained how CollabPM paradigm can be the solution.

- **Information flow**

Traditional project management implied that only a few individuals with high hierarchy positions inside the company had the complete picture of a project. These individuals kept all the information regarding the project to them and used it to plan and assign tasks to others. The project team who had to execute the tasks were neither supposed nor allowed to help planning the project, the project members could only access the information related to their individual tasks. As a consequence, it was not too clear for them what the possible effects their individual work might have had on the whole project. However, in the new project management paradigm, called CollabPM, the project manager behaves as a coordinator rather than a dictator. Therefore, project members are allowed to share project information, make decisions and have responsibility related to project outcomes. The information flow is in all directions rather than being kept just for the company´s high positions (Chen et al., 2002; Chen, Romano, & Nunamaker, 2006).

- **Tracking the project**

Another serious problem of the traditional project management approach is that it was not too much focused on controlling the project's work (Romano, Fang, & Nunamaker, 2002). Projects are, by their nature, very dynamic. Therefore, changes to the original project plan can happen as it evolves. Without the close monitoring of the project, the current project status may not be fully clear to the project manager and to the team. When the status is unclear, members are unaware of when something has gone wrong or something changed on project work until the problems arise. Furthermore, without tracking the project work, it is also difficult, if not impossible, to estimate risks caused by changes, as well as to identify alternatives to mitigate those risks in an efficient and timely manner. While in traditional project management project tracking is insufficient, the CollabPM emphasizes that a close project tracking is a critical factor for the success of the project. Closely monitoring the project helps the project manager and the team to be fully aware of what is happening as the project evolves. As a consequence, they are able to manage the change very quickly. It also increases the probability of identifying, estimating and mitigating project's risks early before they become serious threats to the project's success. Moreover, a close project tracking can help project managers and their teams to assess

accurately the current project's performance and compare it with the original project's plan (Chen et al., 2002).

- **Management Style**

Because in traditional project management a problem is commonly detected just when it shows up, the traditional project management approach consists of a reactive management. This means that this kind of project management just solves problems or corrects errors. The CollabPM paradigm follows a proactive management, as far as it monitors the project closely, meaning that CollabPM predicts better what may happen and works to avoid problems, as well as it is able to successfully face the problems that arise (Chen et al., 2002).

- **Communication**

Projects with member distribution across different buildings and countries with different time zones will demand high degrees of communication to accomplish the project work. Traditional project management practices are inadequate to address the communication challenges that arise from projects whose members are separated by geographic or temporal space (Rad & Levin, 2003). Untimely communication and not notifying the entire team of some important information are flaws that occur in traditional project management and contribute to a poor communication among dispersed project members. Poor communication among the project collaborators is often cited as the primary reason for project failure (Helbrough, 1995). Furthermore, as previously mentioned, in traditional project management, top-down communication is performed whereas communication in other directions is seldom done. As a consequence, sharing information is minimal and inadequate among project contributors, which may result in an inefficient communication (Chen et al., 2002). CollabPM work environment focuses on efficient communication, that is, on the timely sharing of information and knowledge among project contributors. The overarching goal is to get the right information to the right people at the right time. In CollabPM, high levels of information flow between all project members, thus synergy and idea triggering are easily developed (Rad & Levin, 2003).

- **Document Management System**

While developing projects, project members are commonly more concerned with completing the project work than with capturing and archiving project information that may be useful for the future. Project information such as processes, used tools, methodologies and rationales are often not documented and retained at all. If the collaborators do not document, share and archive the rationales that they used to perform the work, other team members may not be able to perform the same job with the same precision.

Furthermore, traditional project management lacks a document management system. The project's documentation exists as disjointed documents which are stored in file folders of several computers. The project's documentation exists in a decentralized way, that is, the documents are stored in folders of several computers or in individual hard disk drives.

This may end up creating information islands and causing a lack of effective sharing of project documentation among the collaborators. Because of these information islands, project members may not be aware that a similar task to their own was already performed and documented in the past. If there weren't the information islands, the project members could use some of the documented processes instead of creating something from scratch.

In projects with a distributed team, documenting, archiving and sharing project information, as well as successful lessons learned, are key elements. For CollabPM, the explicit documentation of project information and successful learned lessons facilitates an efficient communication.

Furthermore, for CollabPM, all the documents related to the project must be systematically stored in a document management system. The document management system serves as a project memory and all documents or information about the project must be stored there. The document management system also allows manage and share project information efficiently. Documents can be organized and indexed, allowing the project members to easily access, search, and retrieve the documents. Via document management, every project member can access and exchange the information, anytime from anywhere (Chen et al., 2002; Romano et al., 2002).

To conclude this section, it is important to retain that the CollabPM paradigm has emerged as a vehicle by which the cost and duration of distributed projects can be potentially reduced while maintaining the quality and scope of the projects (Rad & Levin, 2003).

3. SOFTWARE TOOLS FOR PROJECT MANAGEMENT

3.1. The importance of software tools for project management

In the past, project management meant three things: pencil, paper and brains. However, over the last decades, the arising of personal computers (PC) and the growth of Project Management Software (PMS) has especially contributed to change the face of project management (Reiss, 1995). PMS is a class of computer applications specifically designed to manage projects, it aids with planning and controlling resources, costs and schedules of a project. For Marchewka (2003), it is almost unthinkable that anyone would plan and manage a project without the support of PMS. Managing a project involves a considerable data and information analysis that cannot be easily handled without the aid of PMS. Thus, small and large businesses from all kinds of sectors such as technology, industry, education, manufacturing and construction rely on PMS to help business teams manage their projects efficiently

Currently, the marketplace is loaded with hundreds of PMS solutions to assist in project management and most of these packages are relatively inexpensive and rich in features (Conlin & Retik, 1997; Liberatore & Pollack-Johnson, 2003). Nevertheless, a typical PMS has to provide the project manager and other team members with important tools that allow them to register the documentation, define project schedules, manage resources and budget, track the progress of a project and notice potential issues before they arise. Therefore, the PMS tools are mostly applied in the planning and execution phase of the PLC (Jaafari & Manivong, 1998; Levine, 2002; Rocha & Tereso, 2008).

In the following paragraphs, the importance of PMS for the traditional management areas will be described:

- **Defining project schedule**

Before starting to schedule the work, it is compulsory to undertake the first phase of PLC, that is, defining the project goal. The Work Breakdown Structure (WBS) is a technique that can be used to help with project goal definition and with breaking it down into tasks. The WBS is an organizational chart for the project work, with a top-down hierarchical structure. On the top of the

hierarchical structure, there is the project goal and below are the tasks that specifically define the work to be done (Kemp, 2006). Once the list of tasks is defined, it is required to assign the duration of each task and identify the dependency relationship between them. The most common approach to establish task duration is to come up with an estimated time. Furthermore, for scheduling the work, the project manager can also impose dates, for example, the project´s start date. All this information (list of tasks, task durations, task dependencies and imposed dates) should be further listed in the PMS. Based on this information, the PMS can automatically calculate the critical path and the project´s end date (Jalote, 2002; Levine, 2002). Therefore, PMS have become important tools in helping project managers with the most complex and lengthy calculations such as the determination of schedules.

- **Allocating resources**

The first computed schedule is not very realistic: it assumes that there are unlimited resources available to fulfill the work. Obviously, this is not a good assumption because generally the resources are somehow limited. Therefore, by using the PMS it is needed to adjust the preliminary schedule to consider the availability of resources (Levine, 2002). In terms of resources allocation, it is initially necessary that the project manager and the team define which resources are needed to perform the tasks, as well as, the quantity and availability of each resource required for each date (Rocha & Tereso, 2008).

The PMS is also important for the project manager to dispatch the tasks more efficiently and quickly to the appropriate employees. This allows project managers to spend more time in activities that are really important for the project (Rocha & Tereso, 2008; Tatnall & Shackleton, 1995).

- **Determining budget**

By assigning a cost rate to each resource and adding fixed costs to others resources, the PMS is able to generate a cost estimation for each task. Thus, with PMS, building a time-phased budget is easy (Levine, 2002).

- **Simulation/ What if scenarios**

According to Levine (2002, p. 6), "This is where we really begin to see the PMS pay dividends. With PMS is easy to do what-ifs". Based on the project calendar, the budget and the resources allocation mentioned above, it is possible to settle down an initial network of the project, or in other words, a baseline project plan. Using a PMS, the project manager can test different options or simulate alternative scenarios on this initial network. Let's take a look on the following example to understand what-if scenarios mean. If time is a project constraint, several scenarios can be tested to solve this problem: (1) overlapping or expediting some of the tasks, (2) making changes in tasks dependency and in their durations, (3) increase the number of resources and consequently the costs, 4) make a mix of the previous scenarios. All this computerized simulations provided by the PMS will allow the project manager to understand which is the best option or combination of options to deal with the constraint he or she is facing (Rocha & Tereso, 2008; Roldão, 2000; Ware, 1991).

Furthermore, what-if scenarios can also be used to assess the feasibility of the project schedule under adverse conditions. By computing different scenarios related to potential external factors, such as the delay of a major component by the supplier, a change in the permitting process or a strike, will allow the project manager to prepare contingency and response plans to overcome or mitigate the impact of these unexpected situations (Project Management Institute 2008; Levine 2002).

- **Tracking the project**

As the projects progress, changes that affect the entire network can happen. Consequently, it is essential to quickly update the whole network, and that is something that cannot be done without the use of PMS. By using PMS each team member can update its work status very easily, as well as closely following the work progress of the rest of the team.

PMS is also an important tool for project managers as it allows to track in a timely manner the project performance regarding work execution, costs and resources. Hence, the project manager can also have a better understanding of where the project stands in comparison to the initial project baseline plan (Rocha & Tereso, 2008; Ware, 1991).

Because the PMS is focused on keeping people up-to-date on a project's progress, it eliminates the need for status update meetings and emails. Also, keeping a project on track throughout its execution can help save money by eliminating the chance of a missed deadline (Kemp, 2006; Levine, 2002; Tatnall & Shackleton, 1995).

To sum up, nowadays, anyone who wants to manage projects in a fast and efficient way can only achieve it using the support of PMS. However, to take full advantage of PMS it is essential to ensure that project employees are appropriately trained to use them. It is also important to note that PMS cannot and will never replace the need for dedicated and experienced project managers. Thus, companies may need to train people internally or recruit competent and qualified people to manage their projects efficiently.

3.2. Types of project management software

There are basically two different ways in which PMS are made available by vendors and service providers. Currently, PMS is available as desktop and web-based applications.

- **Desktop project management software**

A desktop PMS is a software that is installed on the computer and runs on the desktop of each user. The desktop application works on the basis that only a single user will need to edit the project plan at any time. Moreover, in this type of application, the project data is stored in a local file or in a central database. The biggest advantages of a desktop application are that it runs faster and has a better response time than web-based solutions. Also, it offers a highly graphical interface. However, the desktop PMS have the disadvantage of being a single-user application and the informatics team will have to periodically dedicate time to ensure that the software remains up-to-date and optimized (Rocha & Tereso, 2008; Schwalbe, 2006).

- **Web-based project management software**

Here, the PMS is implemented as a web application and can be only accessed through a web browser. Benefits of web-based PMS include the fact that they can be accessed from any type of computer without installation need and allow the access of multiple users simultaneously to a central data repository. Thus, with a web-based PMS the project team has easy access and control to information from anywhere. However, it is important to notice that the project information is only available when the user is connected to the internet. This kind of applications can be automatically updated and maintained by the service provider. Also, a web-based PMS tends to come with a monthly charge, which is generally cheaper than buying and maintaining a desktop PMS (Rocha & Tereso, 2008; Schwalbe, 2006).

The two available types of PMS - desktop and web-based - can also be divided according to their license, respectively: open source and proprietary.

Open source

The PMS whose source code is available are called open source and they allow the users to modify or improve the software (Ghapanchi & Aurum, 2012). This type of software can usually be acquired via internet and normally without any kind of payment.

Proprietary

On the other hand, proprietary PMS do not provide the source code, which means that users cannot modify or improve the program. Usually, this kind of software has a cost. Furthermore, the producers provide a support team to help solve the problems that customers may have with the software (Rocha & Tereso, 2008).

3.3. Available project management software packages

The project management software market provides hundreds of PMS packages to companies and individual users that intend to use software solutions for solving organizational and collaborative issues related with project management. Figure 2 shows some of the PMS packages that are available on the market. These PMS packages were divided taking into account their type (desktop or web-based) and their respective license (Rocha & Tereso, 2008).

3.4. Collaborative project management software

The Project Management paradigm has changed not only in terms of how projects are managed but also in terms of computing environments. The authors Chen et al. (2006) pointed out that unlike local projects, in globally dispersed projects, face-to-face interactions among project contributors are often impossible, therefore the information technology designed to support the projects at a single location, is becoming inadequate. As the number of distributed projects increases and the project management shifts towards a CollabPM paradigm, information and communication technology solutions are needed for converting physical collaborative actions into virtual ones (Evaristo & Fenema, 1999; Kliem & Anderson, 2003).

Computer networks have enabled individual and organizations to communicate and work together across time and space barriers. Through computer networks, any collaborative information system can be deployed (Baek, Shek, & Liebowitz, 1999; Nunamaker et al., 2001).

As organizations deal with projects with distributed teams, the management, communication, coordination and tracking of ongoing project work must rely on a specific kind of collaborative information system, called Collaborative Project Management Software (CollabPMS) (Romano et al. 2002).

The CollabPMS helps people manage projects and collaborate more easily regardless of their geographical location (Chen et al., 2002).

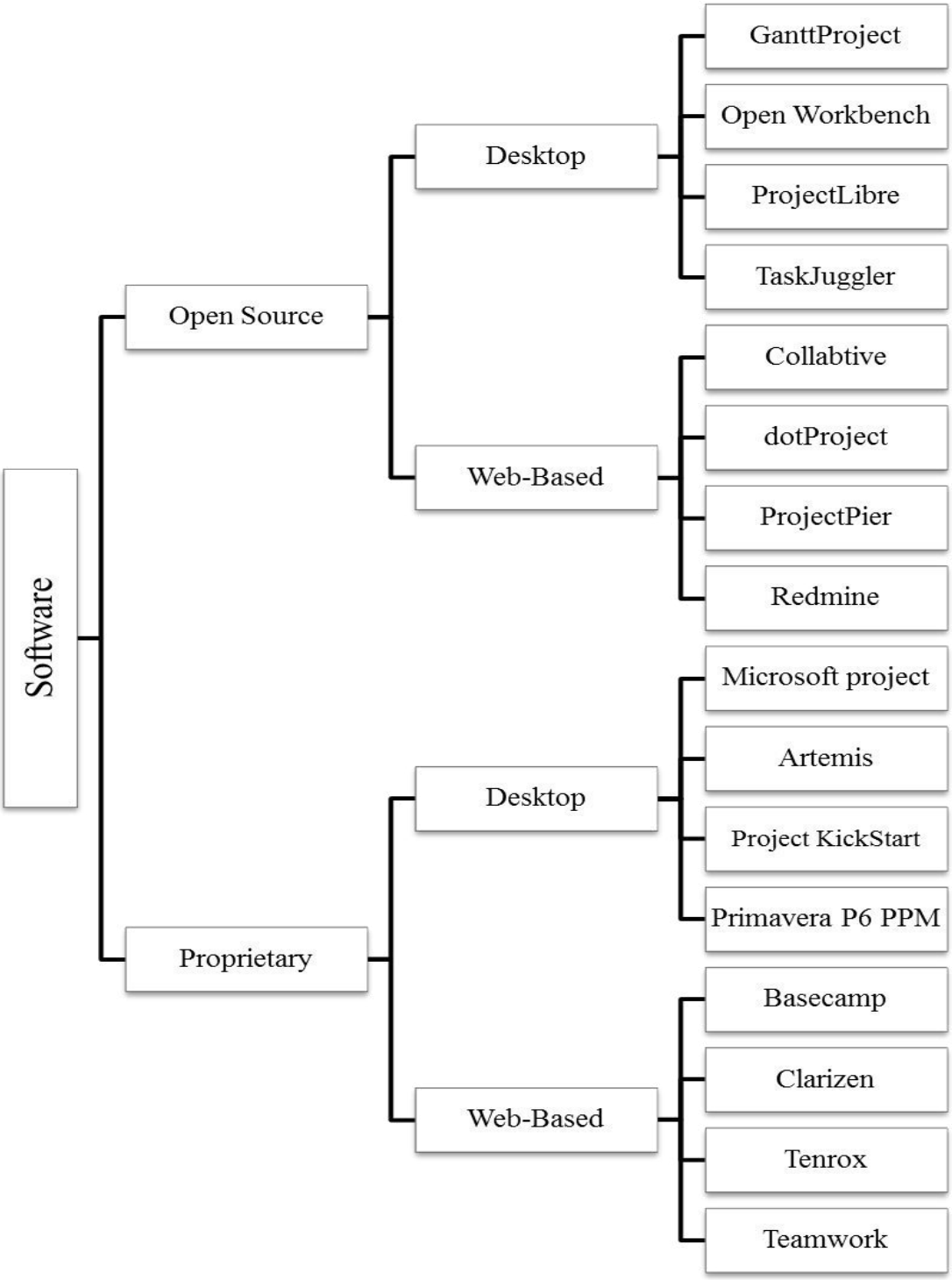


Figure 2: Some of the PMS packages available in the market, adapted from (Rocha & Tereso, 2008)

The CollabPMS should support the typical PMS functions already mentioned in section 3, such as scheduling, managing costs, allocating resources and tracking. The CollabPMS have to support also other functions to create a CollabPM environment (section 2.6), (Chen et al., 2002). Therefore, the CollabPMS should support an efficient inter-member communication among distributed team members (Hill, 2004; Nidiffer & Dolan, 2005). Another purpose of CollabPMS should be to disseminate project information in a faster and effective way among project stakeholders. All intervenient project parties need to exchange ideas and data during the project. The CollabPMS gives them a way to collaborate by sharing documents, timelines and status updates almost instantaneously (Kliem & Anderson, 2003).

Evidence that CollabPMS have been considered of great usefulness by project managers is the fact that over the past years, the sales have increased a lot. It is estimated that revenues from CollabPMS packages raised from US$888 million in 2002 nearly to US$7.2 billion in four years (Chen et al., 2006).

Levels of collaboration

Although many companies claim they have CollabPMS packages, they are not all equal. Depending on the type of computer applications that they have, these CollabPMS can support different levels of collaboration. By definition, collaboration is a joint effort to attain a common goal (Nunamaker, Romano, & Briggs, 2002). As people collaborate, there are at least two hierarchic levels in which they can work to achieve the project´s purpose, namely coordinated work and concerted work (Figure 3).

The higher a team operates in the hierarchy of collaboration, the higher the task structure is and the more demanding the communications interactivity is.

In the following paragraphs, the team productivity, task structure, and communications interactivity of each level of collaboration will be described. Moreover, the typical computer applications that CollabPMS should have to support each mode of collaboration will also be reported.

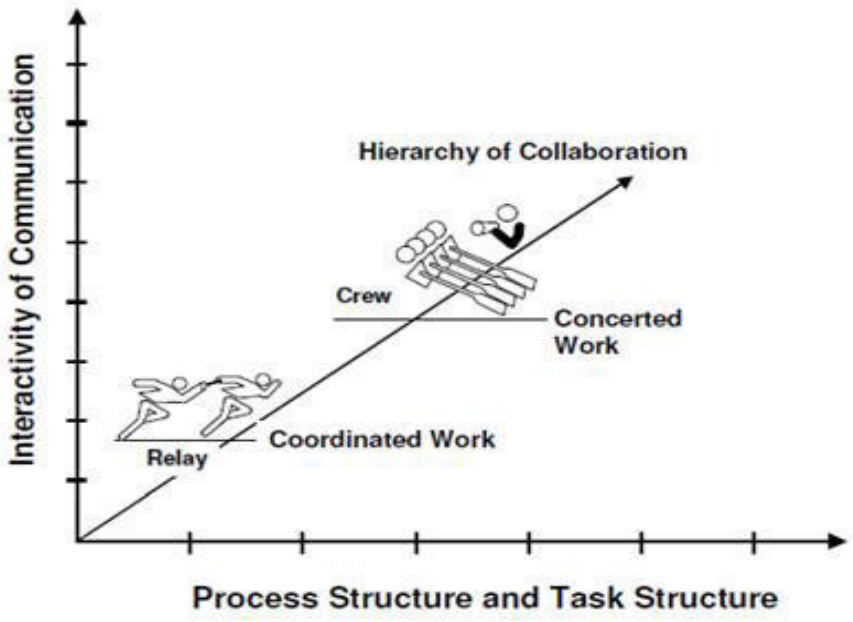


Figure 3: The hierarchy of collaboration, adapted from (Nunamaker et al., 2002)

- **Coordinated Level**

In this collaboration level, team members make individual performances. However, the success of each team member depends on the timely receipt of deliverables from other members. This mode of work is like a team of relay runners, in which each runner makes their best individual performance, but also, must carefully coordinate the handing of the stick to the next runner, figure 3. Therefore, team productivity depends on the ability to coordinate efforts and is the sum of the sequential individual performances. Regarding the task structure, the project tasks follow a sequential order and there is a progressive integration of the work. That is, tasks are coupled among them and the work produced by each team member in each task is integrated in the next tasks. Thus, it is essential to manage the interdependencies between tasks. Because, in this level, the coordination among project team members is required, there is a great need of interactive communication (Chen et al., 2006).

Typical computer applications to support coordinated work include:

Electronic mail (e-mail): is a system for sending and receiving messages electronically over a computer network.

Workflow automation: is a technology solution, which automates the tasks, resources and internal operations that form the process known as workflow. Workflow automation increases the efficiency of a workflow by improving the coordination of the activities of the people involved. Workflow automation helps to ensure that, at the right time, the right person gets the right information about what needs to be done and in what order. To better explain this concept, let's take a look at the following example; an insurance company can use a workflow automation application to ensure that a complaint is handled consistently, from the costumer´s initial call until the company`s final answer. The workflow application can ensure that each person handling the complaint uses the correct online form and successfully completes the previous step before allowing the process to proceed to the next person and procedural step.

Group calendaring: is an electronic calendar that displays events to a defined group. The most basic group calendars show the date and times of events, while more advanced group calendar applications may include functions such as email notification and subscriptions to changes in the calendar. Group calendaring let users view and share each other's calendars and allows a project member to set up a meeting with other members. In this situation, team members are automatically e-mailed (Chen et al., 2006; Nunamaker et al., 2002).

- **Concerted level**

The concerted level represents a higher level of collaboration. At this level, the performance of any member may directly and immediately influence the performance of all members. Thus, the concerted level requires tight coordination among project individuals. A crew team is a useful metaphor for this level of collaboration work. All "rowers" must synchronize their efforts and contribute simultaneously and synergistically to achieve an ideal performance, figure 3. Thus, team productivity is the sum of all concerted team performances. Task structure is more demanding for concerted work than for coordinated work because results need to be continuously integrated and any behavior of each team member directly affects the work of others. Furthermore, at this stage of collaboration, the need for interactive communication is nearly continuous (Chen et al., 2002; Nunamaker et al., 2001).

A typical computer application to support concerted work is:

Group Support System (GSS): can be defined as an interactive information system that structures, supports, and facilitates group interaction. The GSS helps people generate new ideas (brainstorming), organize ideas into categories, and evaluate ideas by voting. A typical virtual meeting using the GSS technology starts with the electronic brainstorming phase, all group members typed at separate terminals their ideas. Afterwards the GSS identifies the key ideas generated from the brainstorming. Lastly, a voting tool provides various methods for prioritizing key terms. The GSS offers another added value by providing support for parallel communication, anonymous interaction and automatic recording of meeting minutes (Hayen, Swaby, & Huang, 2007; Nunamaker et al., 2002).

In order to support the complexities of a distributed project effectively, a CollabPMS must be designed to provide the concerted level of collaboration (Chen et al., 2006; Romano et al., 2002).

4. ANALYSIS OF PROJECT MANGEMENT SOFTWARE PACKAGES

In this section a set of managerial and collaborative functionalities that a CollabPMS should provide to effectively address the challenges of distributed projects will be described. The managerial functionalities that we outlined were Gantt chart, task dependencies, critical path, milestones, resources allocation, budgeting, simulation, project baseline, project tracking, document management system, reporting, portfolio management, import and export data. The collaborative functionalities were email, workflow automation, group calendaring and GSS. Moreover, from the current generation of PMS (figure 2), four were selected to analyze whether they have or not the framework of functionalities described. To show the different types of PMS we selected ProjectLibre (desktop and open source), Redmine (web-based and open source), Microsoft Project Professional 2013 (desktop and proprietary) and Clarizen (web-based and proprietary).

4.1. Project Example

One of the goals of this dissertation is to test a software package. For this purpose, a project example was built up based on the work of Hillier and Lieberman (2010) and it is about constructing a new plant for a major manufacturer.

Table 1 describes the human and machine resources required for the project completion. Moreover, it also describes the type of resource (material or work) and its availability. Regarding the resource costs, it is mentioned the standard and overtime pay rates, as well as, the cost per use.

Additionally, table 2 shows the key activities necessary to build the factory, its predecessors, the task durations in weeks and the human and machine resources that are required in each task.

Table 1: Project data regarding human and machine resources adapted from Hillier and Lieberman (2010)

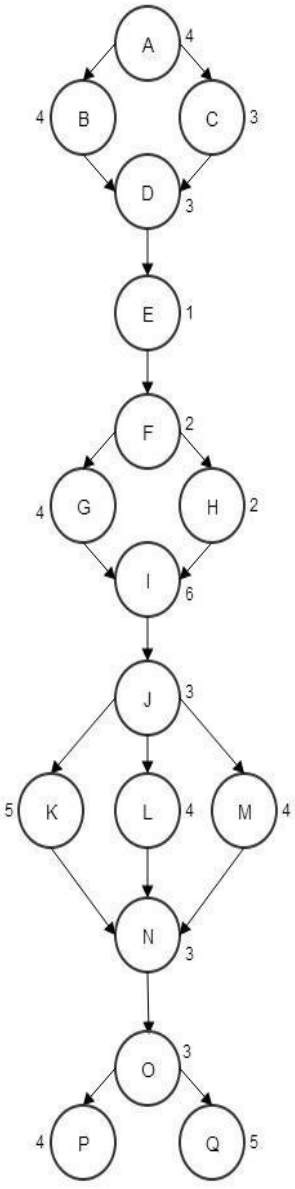
Human and Machine Resources	Initials	Type	Availability	Standard Rate	Overtime Rate	Cost per use
Industrial Engineer	IEng	Work	1	18€/h	23€/h	
Architect	Arch	Work	1	18€/h	23€/h	
Civil Engineer	CEng	Work	1	18€/h	23€/h	
Foreman	Fo	Work	1	12€/h	16€/h	
Construction Worker	CW	Work	5	6€/h	7,5€/h	
Grader Operator	GrO	Work	1	10€/h	13€/h	
Backhoe Operator	BaO	Work	1	10€/h	13€/h	
Crane Operator	CrO	Work	1	10€/h	13€/h	
Electrician	El	Work	2	10€/h	13€/h	
Electrician Helper	ElH	Work	2	6€/h	7,5€/h	
Plumber	Pl	Work	2	10€/h	13€/h	
Plumber Helper	PlH	Work	2	6€/h	7,5€/h	
Painter	Pa	Work	2	10€/h	13€/h	
Painter Helper	PaH	Work	1	6€/h	7,5€/h	
Grader	Gr	Material		250€		50€
Backhoe	Ba	Material		250€		50€
Crane	Cr	Material		250€		50€

Table 2: Overall project data adapted from Hillier and Lieberman (2010)

Activity	Activity Description	Predecessors	Duration (weeks)	Human and Machine Resources
A	Facility layout	—	4	IEng, Arch
B	Architectural design	A	4	IEng, Arch
C	Technical plan	A	3	CEng
D	Building permit	B, C	3	CEng
E	Land grading	D	1	Fo, GrO, Gr
F	Excavations & Trenching	E	2	Fo, CW, BaO, Ba
G	Foundations	F	4	CEng, Fo, CW, CrO, Cr
H	Laying the pipes	F	2	CEng, Fo, CW, El, ElH, Pl, PlH
I	Assembly the metallic structures	G, H	6	CEng, Fo, CW, CrO, Cr
J	Roof	I	3	CEng, Fo, CW, CrO, Cr
K	Coating the metallic structures	J	5	CEng, Fo, CW, CrO, Cr
L	Electrical work	J	4	El, ElH
M	Plumbing	J	4	Pl, PlH
N	Install the flooring	K, L, M	3	Fo, CW
O	Interior partitions - office section	N	3	Fo, CW
P	Interior painting	O	4	Pa, PaH
Q	Exterior painting	O	5	Pa, PaH

Some of project data shown in table 2 can also be displayed graphically as a project network (figure 4). The project network diagram enables a better visualization of the flow of the activities and helps in the project analysis. The project network displays the activities (nodes) and

the precedence relationships between them (arrows). Between all the activities/tasks were established the F-S dependencies, which means that each predecessor task finishes before the successor task starts. The number next to the node represents the estimated duration (in weeks) of each activity.



A Facility layout

B Architectural design

C Technical plan

D Building permit

E Land grading

F Excavations & Trenching

G Foundations

H Laying the pipes

I Assembly the metallic structures

J Roof

K Coating the metallic structures

L Electrical work

M Plumbing

N Install the flooring

O Interior partitions - office section

P Interior painting

Q Exterior painting

Figure 4: Project network diagram

4.2. Managerial Functionalities

For Jaafari and Manivong (1998) an ideal CollabPMS should afford managerial functions capable of answering to the challenges placed by the project team and providing, at the same time, an integration of all the project's processes over its life cycle.

Based on the work developed by Jaafari and Manivong (1998) we selected a series of managerial functionalities that a CollabPMS should offer to help perform an efficient management of distributed projects.

Using the project example presented in the previous section about constructing a new plant for a major manufacturer, it will be possible to test and further evaluate whether ProjectLibre, an open-source and desktop PMS, has or hasn´t the managerial functionalities that we proposed to help perform an efficient project management (ProjectLibre, 2013).

The worldwide reputed newspaper Computerworld, a leading source of technology news and information, named in June of 2013 the ProjectLibre as one of the exciting new open source PMS (Computerworld, 2013). The ProjectLibre was released in 2012 and was developed by the founders of the famous open source software OpenProj and it is a major open source addition as the leading alternative to Microsoft Project (ProjectLibre, 2013). The ProjectLibre software was downloaded on Sourceforge, and its programming language is java, which allows it to run on the main operating systems as Linux, Mac OS X and Microsoft Windows (Sourceforge, 2013).

Each of the following topics represents the managerial functionalities that we outline to perform an efficient project management. In that same topics, is also described a step by step approach to check whether ProjectLibre displays or not the desired managerial functionalities.

- **Gantt Chart and Task dependencies**

For Marchewka (2003, p. 150), "although Gantt charts have been around for a long time, they are still one of the most useful and widely used project management tools". The key reason why Gantt charts are still so popular is that they are well understood, easy to create and revise (Jurison, 1999; Project Management Institute, 2008).

Gantt charts are a simple, straightforward, and useful graphical application that shows the schedule information. With Gantt charts, it is possible to get a preliminary idea about the time

structure of a project; they portray the project activities against a horizontal time scale (Marchewka, 2003; Prince, 2009).

The traditional form of Gantt chart simply displays the duration of each task drawn against time without indicating dependencies (Kliem & Anderson, 2003). Nevertheless, the Gantt chart used today in most PMS packages has already been modified to overcome these limitations. Presently, practically all Gantt charts allow to illustrate the relationship or dependencies among tasks (Grundy, 2001; Howes, 2001).

To fully understand the functionality of the Gantt chart of ProjectLibre, several steps were undertaken.

To start with, it was necessary to set up a new calendar for the project because none of the default calendars that ProjectLibre provides considers public holidays. Therefore, the new base calendar, assumed that human resources work a standard week, Monday through Friday, from 8 a.m. to 5 p.m. with one hour lunch at noon, except on public holidays where there is no work.

Afterwards, the project tasks and its duration (table 2) were listed on the left table of the Gantt chart. By grouping tasks under a parent task/summary task (see bold tasks in figure 5), several work phases were created, providing a hierarchical structure to the project.

At this stage, the Gantt chart is still not completed, it is still necessary to indicate the dependencies (table 2) amongst the activities to finalize the Gantt chart. The task dependency concept is explained in the section 2.2. By dragging the mouse, it is possible to set dependencies between tasks. Every time that a dependency is set up between two tasks, an arrow will be displayed on the Gantt chart to show that these two tasks are linked. The ProjectLibre provides the four types of task dependency: F-S, S-S, F-F, S-F. Nonetheless, as has mentioned in section 4, the F-S dependency was the only dependence used to link all tasks of the project example (figure 5).

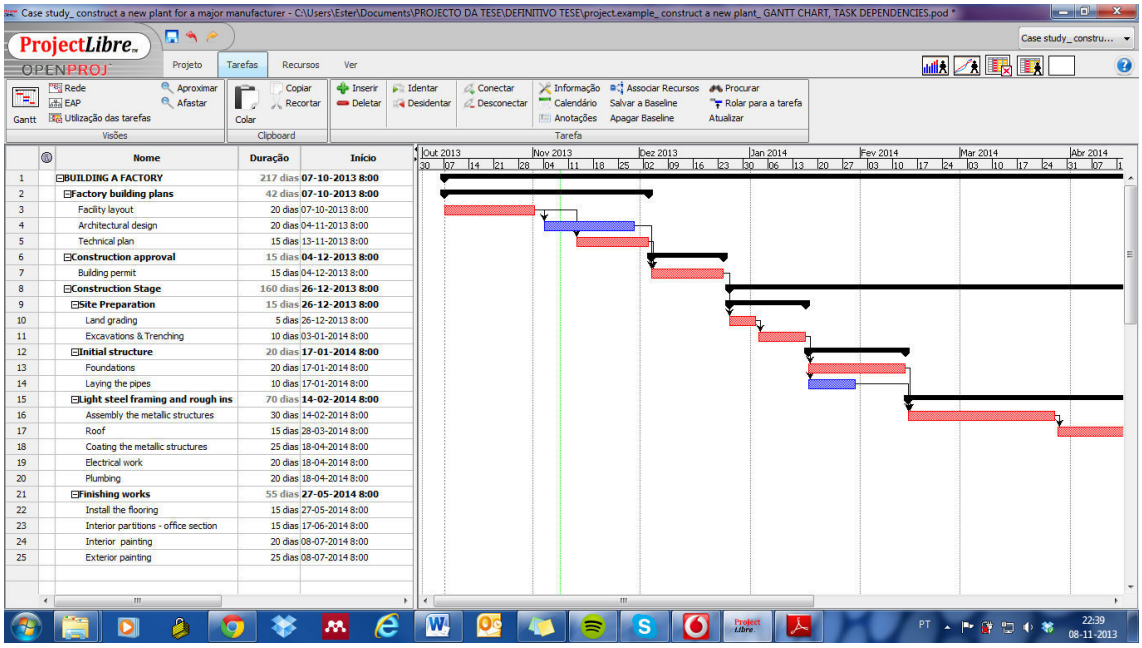


Figure 5: Screenshot of the Gantt chart created using ProjectLibre: 1) the horizontal bars represent the activities' durations across a timeline; (2) the dependencies are represented as arrows.

In appendix 1 (section 8.1), it is possible to see the Gantt chart in the original size.

- **Critical Path**

The critical path is the sequence of activities that take the longest time to be completed, in other words, it is the path of the project network diagram (figure 4) that takes more time to finish. In this case, the critical path drives the completion date of the project (Jurison 1999).

The critical path indicates which activities are the most critical to be performed in time to avoid delaying the whole project. The tasks on the critical path are called critical tasks and require special management attention because any delay in a critical task delays the completion of the project (Wysocki, 2006).

While critical tasks have zero slack, the non-critical tasks can have slack. Total slack describes the amount of time a task can be delayed without compromising the project finish date (Prince, 2009; Project Management Institute, 2008). With ProjectLibre, the critical path and the total slack is calculated and displayed by default on the Gantt chart (figure 6).

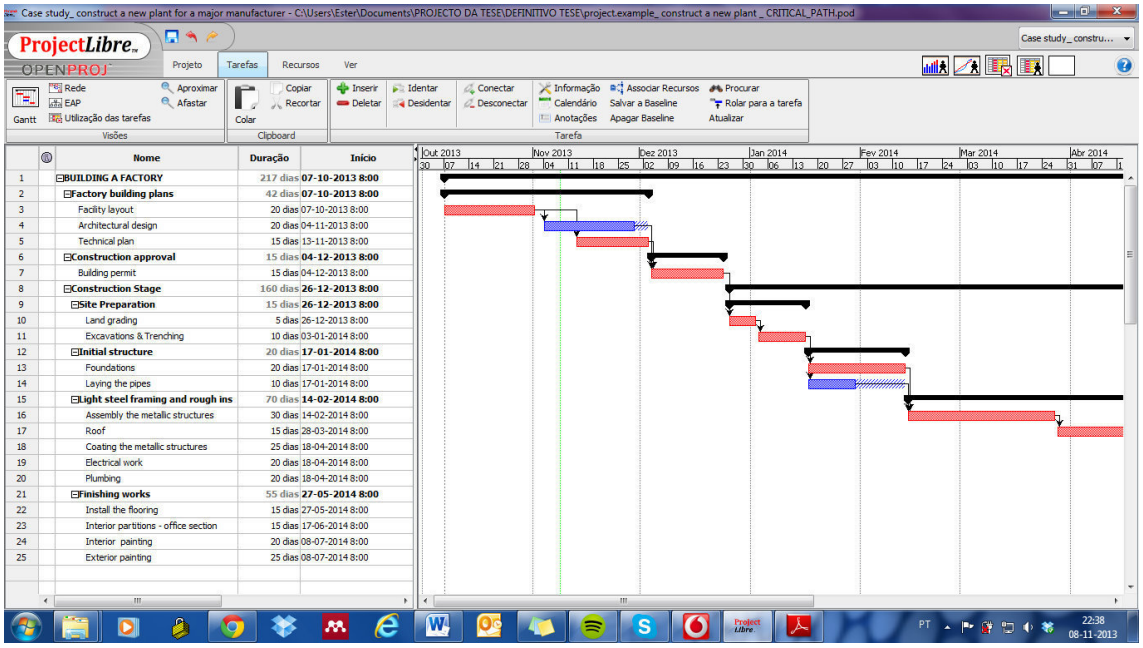


Figure 6: Screenshot of Gantt chart with: (1) critical path highlighted in red, thus while the critical tasks correspond to the red bars, all non-critical tasks correspond to the blue bars; (2) the total slack of the non-critical tasks is exhibited as blue stripes.

- **Milestones**

A milestone is a reference point that marks a major event in a project. Usually, it is used to mark the completion of a group of tasks' phase and to indicate that a specific project's deliverable has been achieved (Heagney, 2012).

Setting milestones can help keep the project on schedule. Milestones allow the project manager to gauge if the schedule itself is proceeding as expected. When a milestone is reached, it is also a chance to revisit the project plan and measure the overall project status (Phillips & Luckey, 2006).

The PMS ProjectLibre allows to establish during the project, several milestones represented by the black diamond symbol (figure 7). The quickest way to create a milestone is by adding a task with zero duration. The milestones represent an achievement and not an action, thus, there is no consuming of resources or time when setting milestones (Schwalbe, 2006).

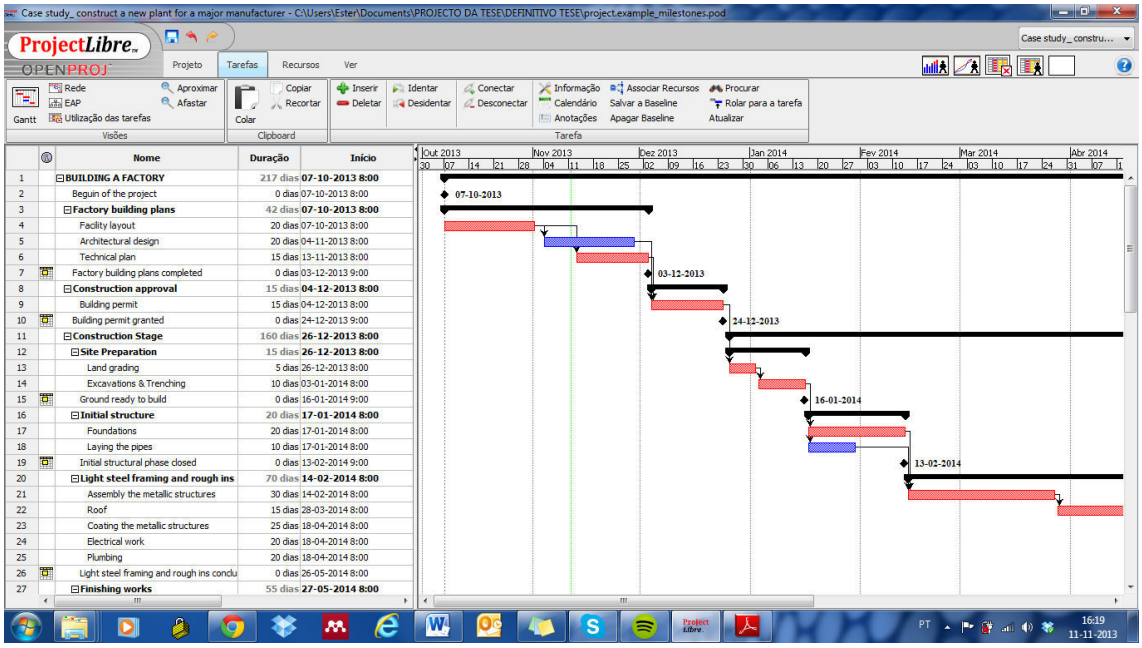


Figure 7: Screenshot of the Gantt chart with the milestones symbolized as black diamond shape.

In appendix 2 (section 8.2), it is possible to see the project´s milestones in the original size.

- **Resource allocation**

In a broad sense, resource allocation is the process of assigning, for a defined period of time, resources for each and every project´s activity (Levine, 2002).

To check the capability of resource planning of ProjectLibre, several phases were carried out. The first phase was filling in the resource sheet of ProjectLibre (figure 8). In this resource sheet, it was necessary to list all the required resources and classifying the resources according to its type (table 1). In ProjectLibre, a resource can only be of two types, work or material. Thus, human resources were classified as work and the machines were classified as material.

Resource availability (table 1) was also considered. Thus an upper limit for the human resources in the column Maximum Units was established. The quantity of people that are available is represented in percentage. For example, if there are just 5 construction workers on the project team, this means that there is an availability of 500%.

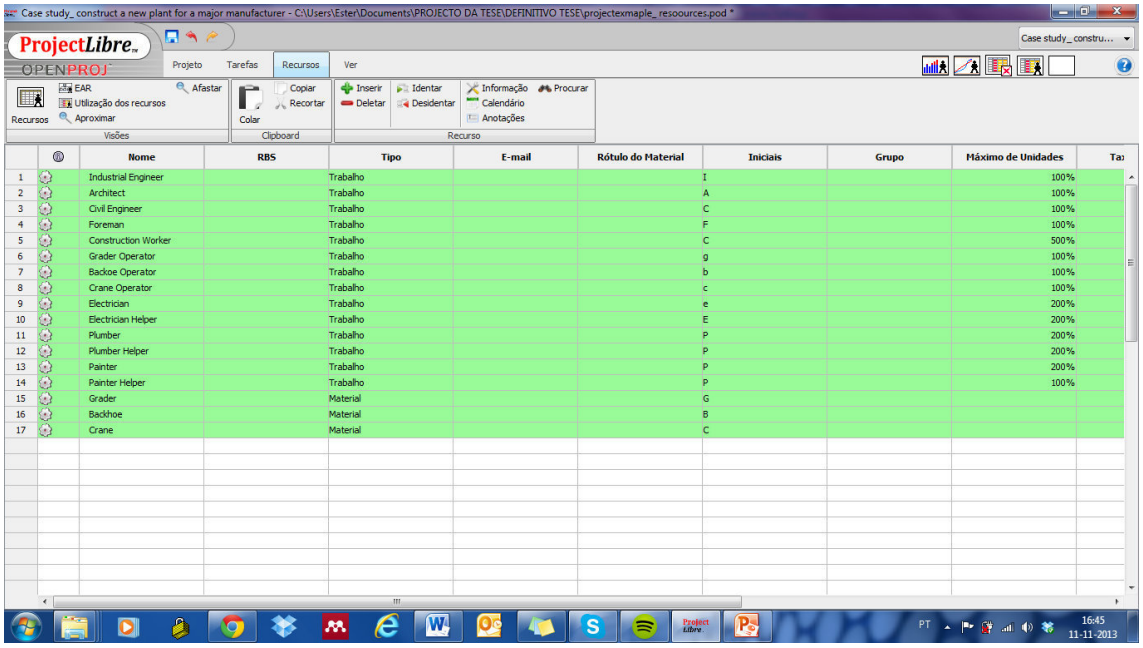


Figure 8: Screenshot of resource sheet of ProjectLibre

The second phase was assigning the resources to the appropriate tasks based on the information on table 2. After assigning them, the resources will appear next to the corresponding bars in the Gantt chart (figure 9).

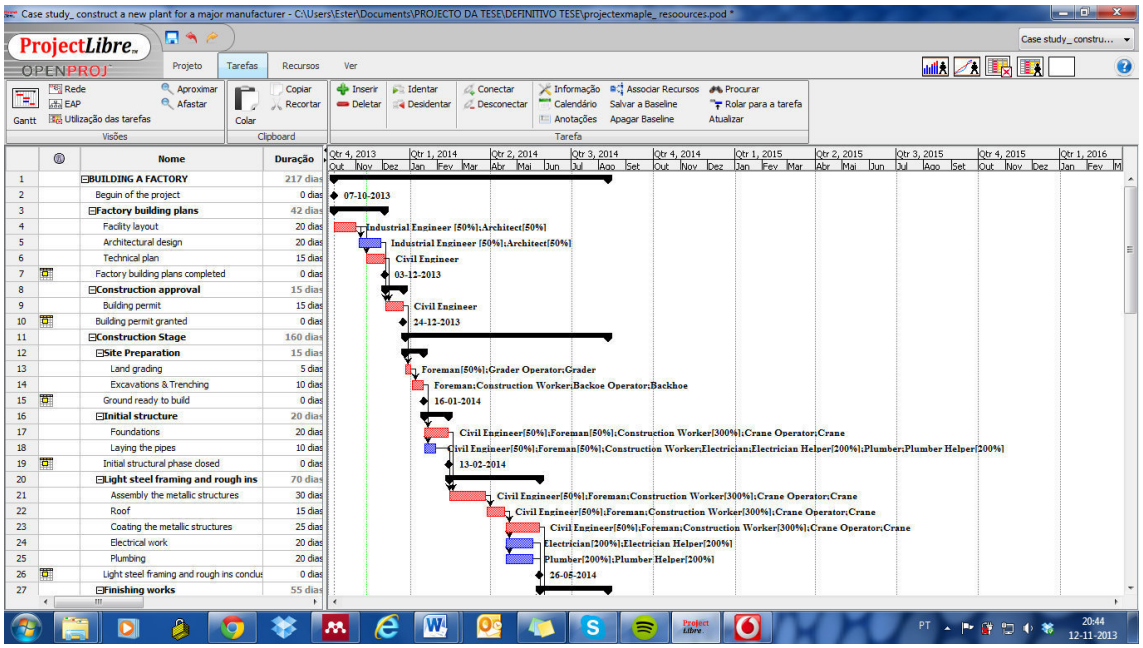


Figure 9: Screenshot of the Gantt chart with resources

In appendix 3 (section 8.3), it is possible to fully view the resources allocation.

The third phase consisted in checking if there was any over-allocated resource, that means, verify the consume of each resource in relation to its availability. Looking to the resource histogram (figure 10) is possible to see that the painter helper is over-allocated, because its availability (black lines) is below its consumption (green). This resource conflict will be handled posteriorly on the Simulation/What if Scenarios topic.

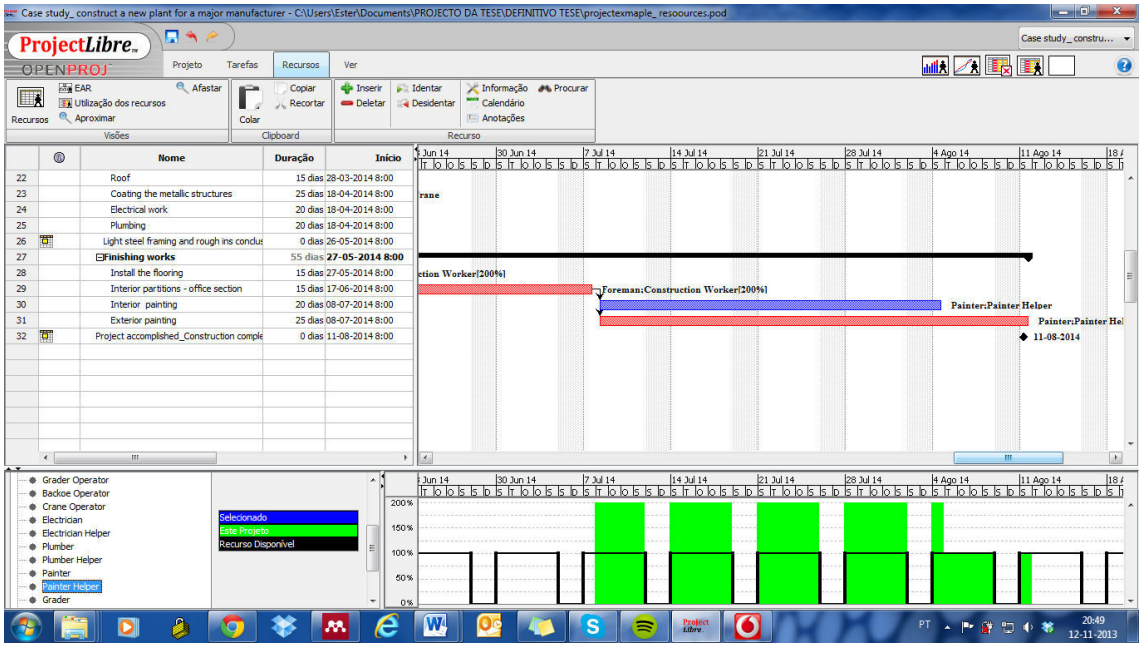


Figure 10: Screenshot of the resource histogram

- **Budgeting**

Project Budget is an important part of project planning and execution (Komchaliaw & Wongthongtham, 2010).

To be able to determine the budget on ProjectLibre, it is necessary to go back again to the resource sheet and add the costs to each resource (figure 11). For each labor resource, standard rates and overtime hours were established. Furthermore, for each material resource, a standard unit rate and a cost per use were established (table 1). A cost per use means a fixed fee for each time that a resource is required. For example, the travel cost of equipment is considered a cost per use.

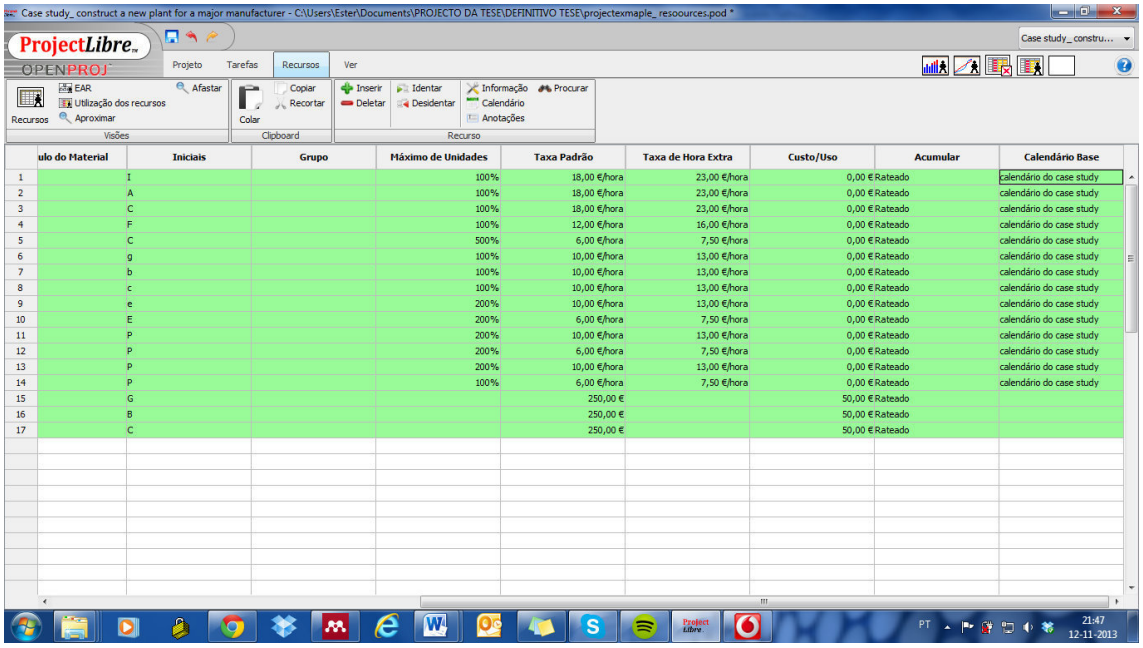


Figure 11: Screenshot of the resource sheet with the costs per each resource

After the costs are introduced, ProjectLibre can calculate the budget for each task, for each phase and for the entire project (see the column costs in figure 12).

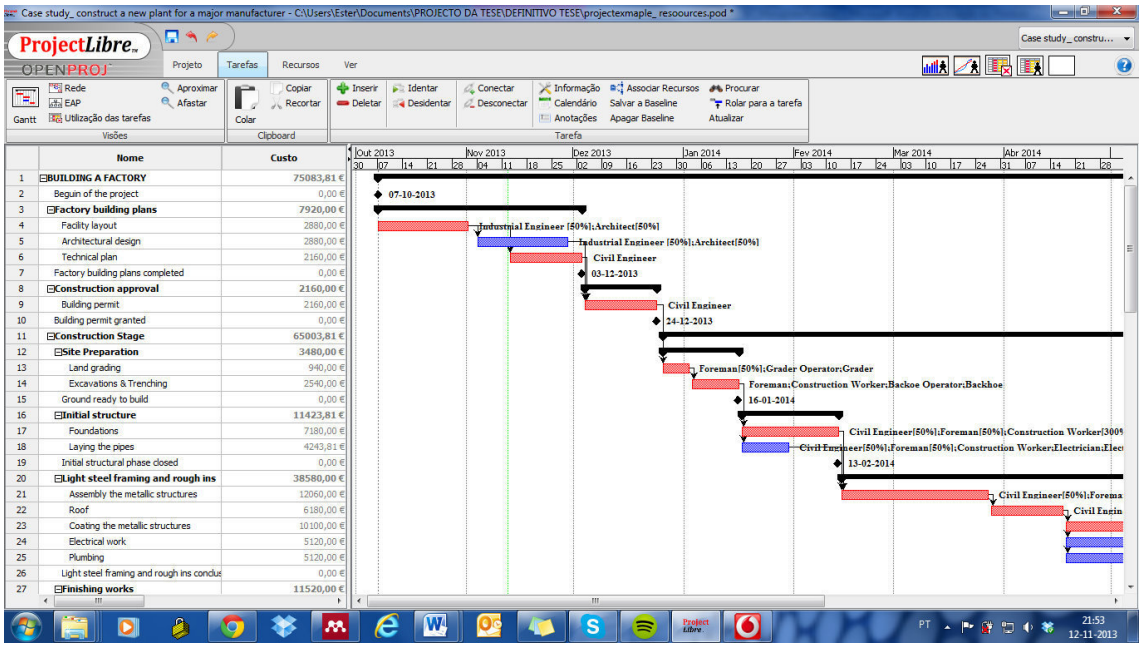


Figure 12: Screenshot of project´s costs

- **Simulation/What if Scenarios**

As it was mentioned in the section 3, the simulation or what-if scenarios allows the project manager to model various scenarios and, in the end, select which are the best options to solve the project´s trade-offs or project constraints.

As was mentioned previously, the project example indicates one resource conflict, the painter helper is over-allocated (figure 10). ProjectLibre allows to test various what-ifs scenarios (figure 13 and 14) to assess which is the best solution to deal with the resource conflict.

Figure 10 shows that interior and exterior painting tasks are developed almost simultaneously and both tasks require the same resource painter helper. To solve the over-allocation of the painter helper without recurring to outsourcing and therefore without spending more money, these two tasks shouldn't be developed in parallel.

Therefore in the first simulation (figure 13), the exterior painting task was postponed by introducing a lag time corresponding to the duration time of the interior painting task. As consequence the resource conflict was solved but the project deadline was also postponed from the original one 11-08-2014 (see appendix 3, on section 8.3) to 08-9-2014 (figure 13).

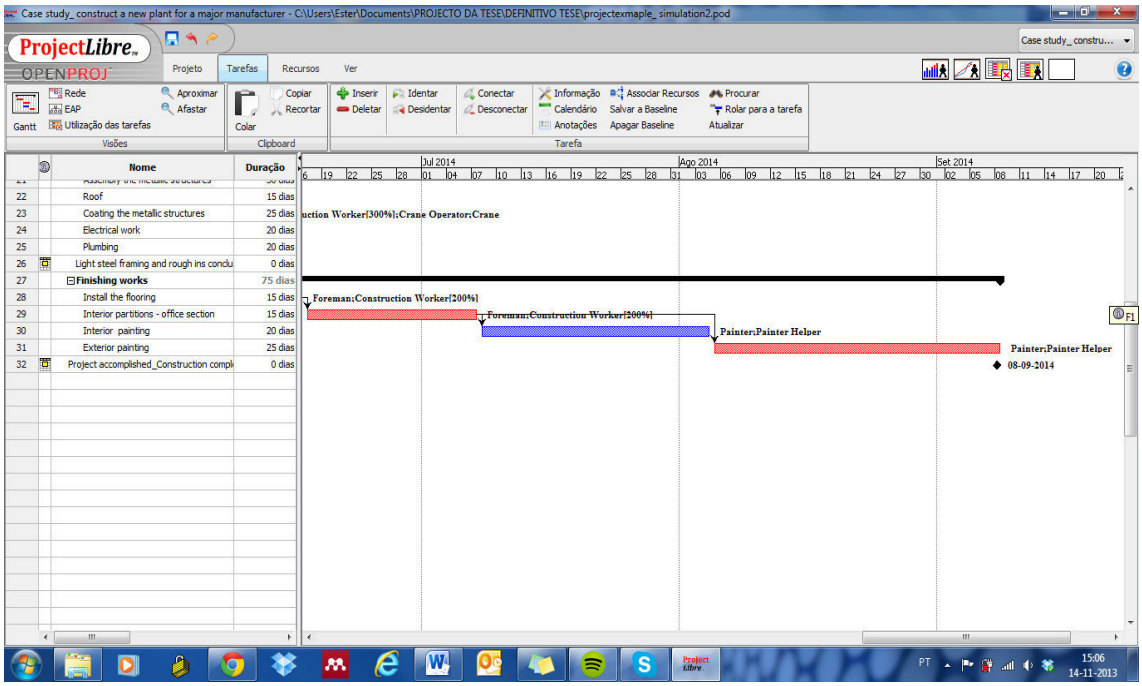


Figure 13: Screenshot of simulation 1: postponing the exterior painting task

Because the first simulation implies the postponement of the project conclusion, a second simulation was carried out. On this second simulation or second what if scenario (figure 14), the exterior painting task will start earlier than what was initially expected, the task will now start on 03-06-2014 instead of the original date 04-08-2014 (compare the exterior painting task from appendix 4 and 3, sections 8.3 and 8.4). This second simulation brings a new important outcome, which is, the project will be concluded earlier than what was initially defined. The project will be concluding on the 04-08-2014, that means 7 days earlier than what was expected (compare the project´s final date from appendix 4 and 3, sections 8.3 and 8.4).

Although both simulations solve the resource conflict, the second simulation can be considered the best solution, besides solving the resource constraint reduces the project duration.

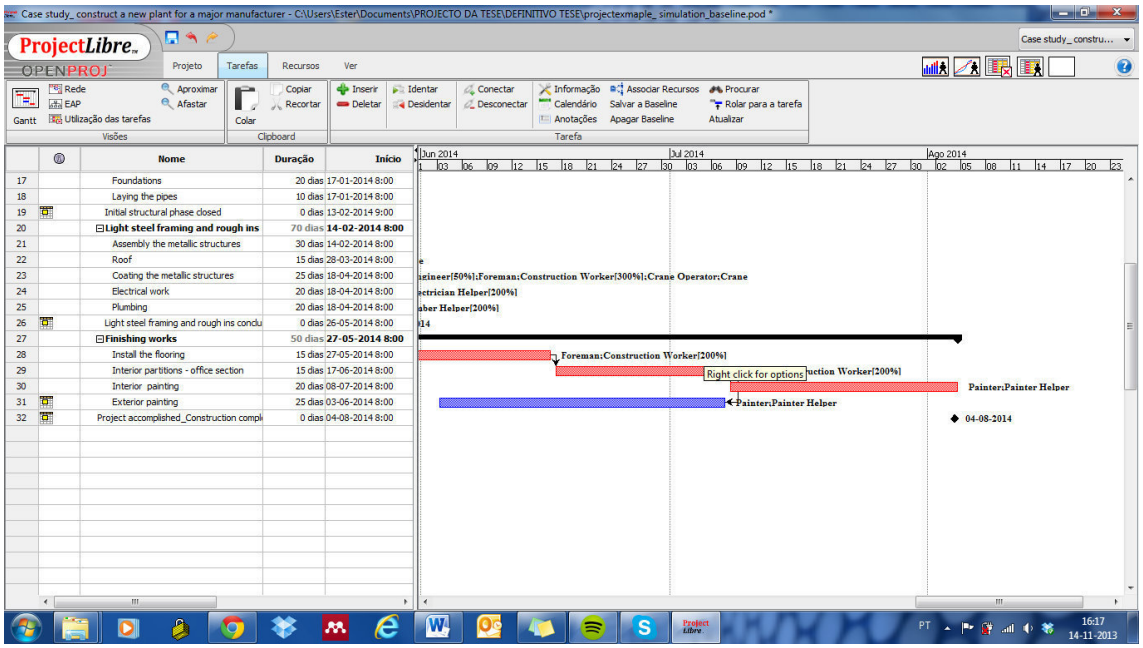


Figure 14: Screenshot of simulation 2: advancing the exterior painting task

In appendix 4 (section 8.4), it is possible to see the original size of the Gantt chart from simulation 2.

- **Setting Baseline**

After the project plan is optimized (see appendix 4) that is, all the constraints and trade-offs between costs, time, and resources of the project are solved by using simulation, it's time to

set or freeze the plan. Setting a baseline plan is useful to measure schedules, resources and cost performance during the project execution (Howes, 2001; Levine, 2002).

In ProjectLibre, the baseline plan can be established by going to the menu and selecting Save Baseline. The gray bars that appear in the Gantt chart (figure 15) indicate that the baseline plan is frozen.

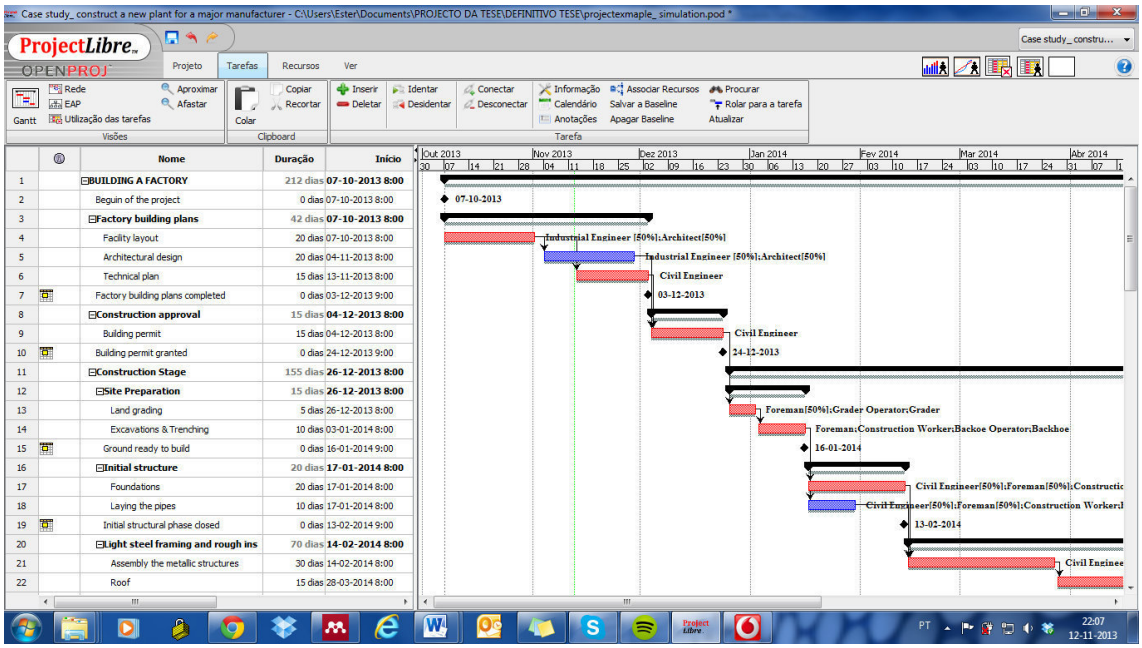


Figure 15: Screenshot of the baseline

- **Project Tracking**

Once the execution of the project starts, the project manager needs to know how the tasks are actually progressing. Project monitoring means keeping your project under control by comparing the baseline plan to the reality and, if something is not proceeding as planned, taking the right actions. The best way to know the project progress is to use Earned Value Management. The Earned Value management is a technique for measuring project performance and progress and it is concerned with ensuring that projects stay within their budgets, while getting the work done on time and at the correct quality (Heagney, 2012). A more detailed description on project tracking can also be found in sections 2.6 and 3.

ProjectLibre allows monitoring the overall project. The Gantt chart of ProjectLibre can be used to monitoring the tasks progress (figure 16). The black bars inside the task bars represent

the level of completion of the tasks or by other words the task status; additionally, the green checkmarks in the status column indicate that a task is fully completed.

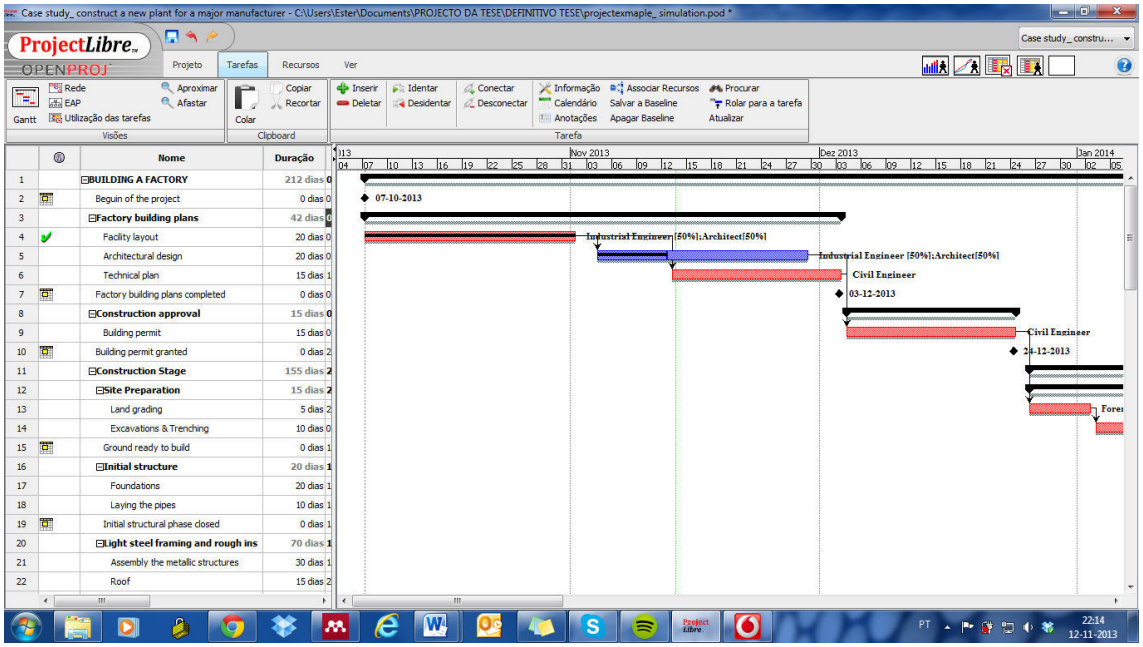


Figure 16: Screenshot of tasks progress

- **Portfolio Management**

A portfolio is basically a group of projects that are grouped together within an organization. How they are grouped is up to each individual organization, but generally, the projects are aligned together when they have the same strategic business objectives (Turner, 2008).

Portfolio management is the centralized management of one or more portfolios that a company is engaged in (Project Management Institute, 2008). The centralized management provides a centralized view of all the projects within an organization. Portfolio management allows financial analysis of the projects, modeling interdependencies between similar projects and dealing with constraints on resources shared between projects (Reyck, Grushka-Cockayne, & Sloper, 2005).

To simplify, a centralized management optimizes the company's "big picture" allowing managers to have an overview of investment, cost, and available resources of the entire portfolio. Moreover, a portfolio management facilitates a better control of all the projects within the

portfolio and ensures that they are always aligned with its organizational strategies (Project Management Institute, 2008; Reyck et al., 2005).

ProjectLibre software doesn't display this functionality. Indeed, with ProjectLibre it is only possible to manage one project at a time.

- **Reporting**

A Guide to the Project Management Body of Knowledge (PMBOK Guide) says that a reporting system provides a standard tool for the project manager to capture, store, and distribute information to stakeholders about the project cost, schedule progress, and performance (Project Management Institute, 2008).

To better control the work of the team members, the project manager will need to access detailed reports on different issues such as: what people are doing, how much resources and budget are being consumed, how is the schedule going, etc. Reports are useful because they show all this information in a structured and objective way. As a consequence, the project manager can straightforwardly analyze the results (Marchewka, 2003).

ProjectLibre provides several standards or predefined reports, some of them are: project details, resource information, task information, who does what. To select this functionality on ProjectLibre, the project manager just needs to find the corresponding icon and afterwards select the reports that he or she wishes to analyze.

In appendix 5 (section 8.5), it is possible to see the predefined report "Who does what", that ProjectLibre offers.

- **Document Management System**

As it was mentioned in section 2.6, document management is a system that allows to handle electronic files more efficiently. Document management focuses in store documents in a secure manner to ensure that they are only accessible to authorized people. Furthermore, using document management, the storage of documents is kept organized. That allows tracking the

different versions of documents more easily as well as retrieving and sharing the documents faster (Chen et al., 2002; Romano et al., 2002). ProjectLibre lacks a Document Management System.

- **Importing and Exporting data**

Importing and exporting data is an important feature that PMS must have for project managers. The possibility of exchanging data with other software tools gives the project´s stakeholders the choice to see and edit the database in other programs.

ProjectLibre provides the possibility to exchange data with Microsoft Project and Microsoft Office Excel by Extensible Markup Language (.*xml) files.

The overall information above about ProjectLibre can be found summarized in the table 3.

Based on published information, that is, scientific papers and information sourced from the software companies' websites, it was possible to perform the same evaluation on Redmine, Microsoft Project Professional 2013 (MPP 2013) and Clarizen. That is, it was possible to verify whether these three PMS have (✓) or do not have (✕) the managerial functionalities that we outlined to perform an efficient project management. The results of these evaluations can also be found in table 3.

As it was previously mentioned in section 3, PMS can be very important and useful for scheduling activities. Effective project scheduling plays a crucial role in ensuring the success of a project. To develop a scheduling plan using a PMS, it is generally necessary to name tasks, the dependencies between tasks and their duration, as well as, any imposed date. Based on this information, the critical path will be identified and the completion date of the project will also be determined (Heagney, 2012; Jalote, 2002; Jurison, 1999; Levine, 2002).

Table 3: Managerial functionalities matrix

Software Name	ProjectLibre	Redmine	MPP 2013	Clarizen
Type of software	Desktop	Web-based	Desktop	Web-based
License	Open source	Open source	Proprietary	Proprietary
Company	ProjectLibre	Redmine	Microsoft Corporation	Clarizen Incorporated
Price	Free	Free	$1,159 per PC	$29,95 /user/month
Trial version	-	-	✓	✓
Gantt Chart	✓	✓	✓	✓
Task dependencies	✓	✓	✓	✓
Critical path	✓	✗	✓	✓
Milestones	✓	✗[1]	✓	✓
Resources Allocation	✓	✗[1]	✓	✓
Budgeting	✓	✗[1]	✓	✓
Simulation/ What´s if scenarios	✓	✓[2]	✓	✓
Setting Baseline	✓	✓	✓	✓
Project tracking	✓	✓	✓	✓
Portfolio Management	✗	✓	✗[3]	✓
Reporting	✓	✓[4]	✓	✓
Document Management System	✗	✓	✗[5]	✓
Importing and Exporting data	XML	XML	XML, CSV, TSV	XML

Analyzing table 3, it is possible to verify that all PMS packages, including ProjectLibre, provide the functionality Gantt chart. That means that with the four PMS packages, the activities'

[1] There is the option of setup a free plugin
[2] Only scheduling simulations
[3] There is the option of setup Project Server 2013 (sold separately)
[4] Reporting only regarding work in progress
[5] There is the option of setup SharePoint 2013 (sold separately)

schedule can be represented in a Gantt chart (Clarizen Incorporated, 2013a; Microsoft Corporation, 2013a; Redmine, 2013a).

As far as task dependencies are concerned, MPP 2013 and Clarizen provide, like ProjectLibre, the four types of task dependency: F-S, S-S, F-F, S-F (Clarizen Incorporated, 2013b; Microsoft Corporation, 2013b). Redmine also offers the possibility of relating two issues (tasks). However, it only allows to establish one type of relationship between tasks, the F-S dependency (Redmine, 2013b).

Redmine exhibits other disadvantages compared to ProjectLibre, MPP 2013 and Clarizen. Indeed, Redmine does not calculate neither displays the critical path (Redmine, 2013c). Therefore, it is more difficult to figure out which activities will determine the project´s end date and how the project should be managed. ProjectLibre, MPP 2013 and Clarizen allow to calculate and highlight the critical path in the Gantt chart (Clarizen Incorporated, 2013c; Microsoft Corporation, 2013c).

When planning a schedule, it is also important to set up the milestones for the project. If a project team succeeds in meeting all of its scheduled milestones, then the project should finish as planned (Marchewka, 2003; Prince, 2009). Milestones are useful for the project manager to evaluate if the schedule itself is proceeding as expected (Grundy, 2001). ProjectLibre, MPP 2013 and Clarizen let establish milestones along the project´s schedule (Clarizen Incorporated, 2013d; Microsoft Corporation, 2013d). The Redmine program does not have this feature. Yet, this issue can be solved by installing a free plugin from the Redmine plugins directory which adds milestones (Redmine, 2013d).

For the planning phase of PLC to be completed, after scheduling the project´s activities, it is necessary to deal with resources and costs planning (Heldman, 2003; Levine, 2002). Looking at table 3, it is possible to verify that ProjectLibre, MPP 2013 and Clarizen allow to carry out the allocation of resources. Thus, similarly to ProjectLibre, with MPP 2013 and Clarizen, it is possible to assign different types of resources to the project´s tasks, as well as, delimit the availability of each resource (Clarizen Incorporated, 2013e; Microsoft Corporation, 2013e). Redmine does not allow resource allocation, however, once again, this problem can be overcome by installing a free plugin for assigning resources (Redmine, 2013e).

Like with ProjectLibre, MPP 2013 and Clarizen allow to calculate the cost of each resource and, in the end, establish a budget for the project (Clarizen Incorporated, 2013e; Microsoft Corporation, 2013f). By installing a costless plugin for budgeting, Redmine is also able of manage costs (Redmine, 2013f).

In relation to the simulation/what-if scenarios and the baseline functionalities, in table 3 it is possible to see that, like ProjectLibre, both MPP 2013 and Clarizen allow the project manager to go into schedule, resources and cost simulations to find the best answer to the project constraints. For Redmine to be able to simulate trade-offs like resources versus time, or costs versus time, the project manager has to install the plugins for budget and resources allocation, otherwise with Redmine it is possible only to make simulations on the project schedule. Furthermore, parallel to ProjectLibre, Redmine, MPP 2013 and Clarizen offer the option of saving the baseline, that is, saving all project data such as schedule data, costs data and resources data (Clarizen Incorporated, 2013f; Microsoft Corporation, 2013g; Redmine, 2013g).

As the execution of the project progresses, it is required to monitor the overall project's performance and make changes to the project's plan as necessary. This is the case for ProjectLibre, MPP 2013, Clarizen and Redmine. All of them afford tracking the project progress (Clarizen Incorporated, 2013e; Microsoft Corporation, 2013h; Redmine, 2013g).

On one hand, from table 3, it is possible to see that Clarizen and Redmine offer the Portfolio Management functionality. Therefore, both Clarizen and Redmine allow organizations to handle multiple projects (Clarizen Incorporated, 2013e; Redmine, 2013g). On the other hand, like ProjectLibre, MPP 2013 does not provide the management of a portfolio. However, it is possible to unlock this functionality on MPP 2013, by installing the Microsoft Project Server 2013, which is sold separately from MPP 2013 and is a flexible program for project portfolio management (Microsoft Corporation, 2013i).

In reference to the reporting functionality, ProjectLibre, MPP 2013 and Clarizen offer a set of predefined reports to see the overall project´s status. These reports can provide information related to work in progress, resources and budget. Redmine also provides a predefined report, but this report only provides information on the work in progress or by other words provides information regarding the task status (Clarizen Incorporated, 2013e; Microsoft Corporation, 2013j; Redmine, 2013g).

In table 3, the functionality of document management system is displayed for Clarizen and Redmine (Clarizen Incorporated, 2013e; Redmine, 2013g). ProjectLibre does not provide a document management system, like MPP 2013. SharePoint 2013 is a paid web application platform developed by Microsoft Corporation that can interface with MPP 2013 and includes document management (Microsoft Corporation, 2013k).

The last functionality in analysis in table 3 is the Importing and Exporting data from Redmine, Clarizen and MPP 2013. Redmine and Clarizen can interface with the different versions of MPP because both allow to export and import entire projects in the XML format (Clarizen Incorporated, 2013g; Redmine, 2013g). Additionally, to create XML files, MPP 2013 allows to import and export data in comma-separated values (CSV) file format and Tab Separated Values (TSV) file format (Microsoft Corporation, 2013l).

4.3. Collaborative Functionalities

Nunamaker et al. (2001), while describing the importance of collaboration, paraphrased a very popular and enlightening adage "two heads are better than one". Collaboration, in its basic sense, can be found all over the society, like in boards and councils, in juries etc. Furthermore, Nunamaker and his co-workers also added that group performance generally exceeds the performance of the average individual.

Thus, it seems logical that particularly for distributed projects, which have project members spread in different places and tasks depending on different team members´ performance, the collaboration between the members is crucial (Evaristo & Munkvold, 2002).

Helbrough (1995) states that poor collaboration is often cited as the reason of project failure, and he envisions that collaborative information systems can manage successfully the collaboration and therefore increase productivity and decrease project costs (Helbrough, 1995).

We used the work developed by Nunamaker et al. (2002) about the typical computer applications that are required to support the coordinative and concerted levels of collaboration, to define which collaborative functionalities a CollabPMS should provide to efficiently support dispersed teams. We define like them that and ideal CollabPMS must be designed to provide the concerted level of collaboration. It is the concerted level of collaboration that adds real value to

project management, therefore an ideal CollabPMS must afford the GSS technology (see section 3.3) (Nunamaker et al., 2002). Moreover we use their work to classify the software packages ProjectLibre, Redmine, MPP 2013 and Clarizen according to the collaboration level that they support. Therefore, it was necessary to evaluate whether these four software packages have (✓) or do not have (✕) the typical collaborative functionalities that are required to support each of the two collaboration levels. Table 4 displays the results of this evaluation.

Table 4: Typical computer functionalities to support each of the collaboration levels

Software Name	ProjectLibre	Redmine	MPP 2013	Clarizen
Type of software	Desktop	Web-based	Desktop	Web-based
License	Open source	Open source	Proprietary	Proprietary
Company	ProjectLibre	Redmine	Microsoft Corporation	Clarizen Incorporated
Price	Free	Free	$1,159 per PC	$29,95 /user/month
Trial version	-	-	✓	✓
Email	✕	✓	✕[6]	✓
Workflow Automation	✕	✓	✕[7]	✓
Group calendaring	✕	✓	✕[7]	✓
GSS	✕	✕	✕	✕

While testing ProjectLibre software we realized that it does not have any functionality to support any of the two levels of collaboration. Therefore we selected Clarizen to better explain the collaborative functionalities of table 4. Clarizen offers its clients several collaborative functionalities, one of which is the communication via email. With Clarizen, team members can exchange emails between them or send directly emails to the entire team (figure 17).

[6] There is the option of setup Lync 2013 (sold separately)
[7] There is the option of setup Lync 2013 (sold separately)

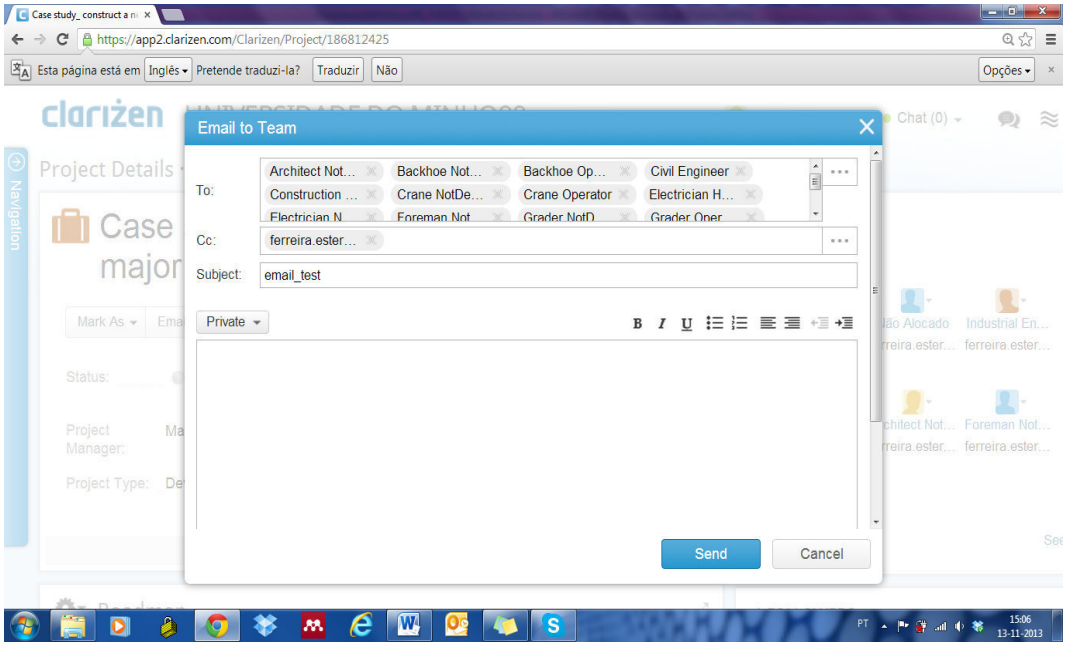


Figure 17: Screenshot of Clarizen´s email functionality

Clarizen also provides workflow automation. By defining workflow rules on Clarizen, it is possible to automate the movement of documents or items through a sequence of tasks (figure 18).

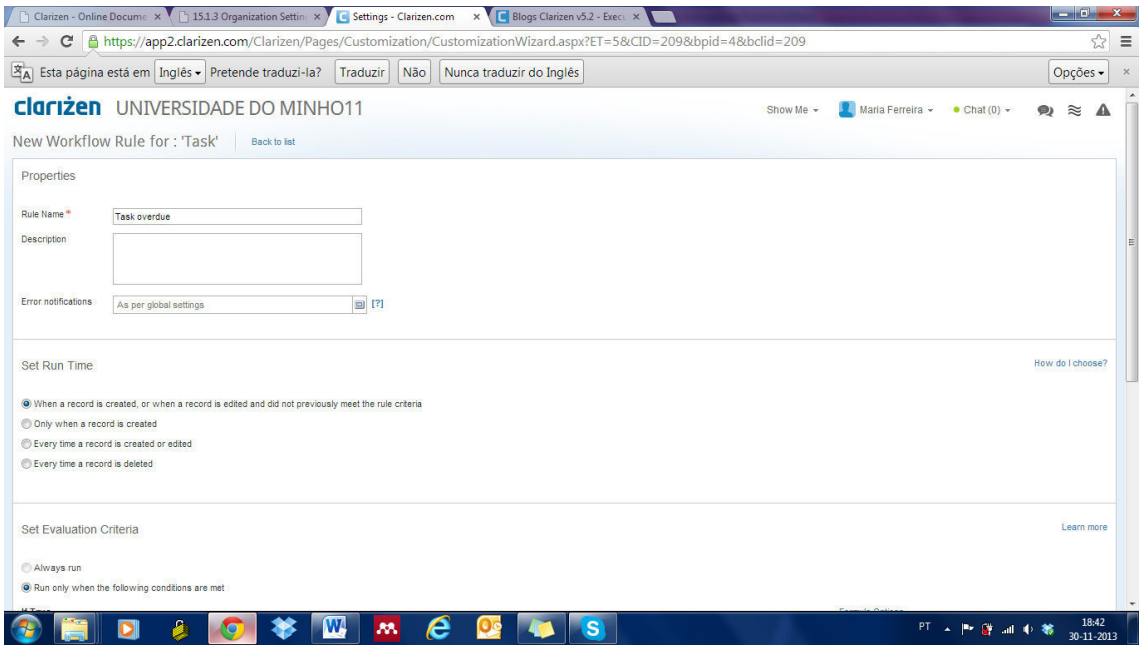


Figure 18: Screenshot of workflow rules

Clarizen has a group calendar or team calendar, which is an electronic calendar that displays events to a defined group. The Clarizen´s group calendar is helpful for project managers to schedule team meetings, because all the team members can see the appointment (figure 19). Clarizen has not adopted the GSS technology.

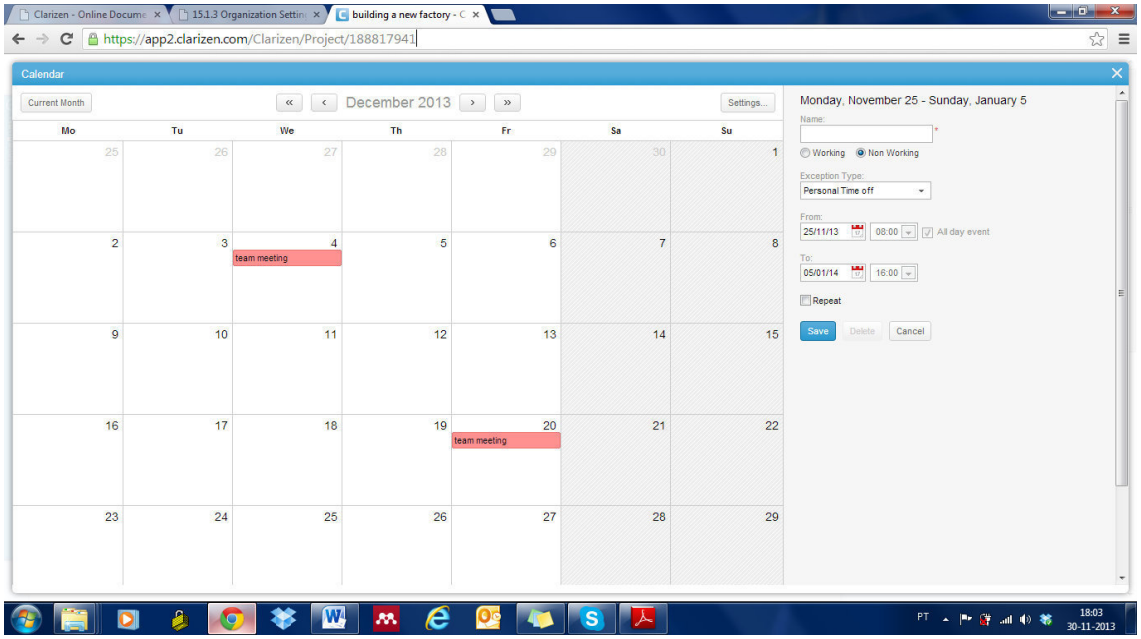


Figure 19: Screenshot of Clarizen´s group calendar

The MPP 2013, commercialized by Microsoft Corporation, does not provide by default the email and the workflow functionality. However, by setting up Microsoft Lync 2013, emails between team members can be exchanged (Microsoft Corporation, 2013m). Moreover, by installing Microsoft SharePoint, it is possible to implement an workflow automation, which allows to integrate procedures and tasks to form a cohesive functional unit (Microsoft Corporation, 2013n). Regarding group calendar, MPP 2013 does not have this capability; however, by setting up SharePoint, this drawback can be solved (Microsoft Corporation, 2013o). It is important to keep in mind that both Lync and SharePoint are sold separately from MPP 2013. Like Clarizen, MPP 2013 does not include GSS.

Redmine provides email, workflow and group calendar functionalities but does not provide the GSS (Redmine, 2013g).

5. DISCUSSION

The review of table 3 shows that Clarizen is the only software package offering, by default, all the managerial capabilities to support an efficient project management. The MPP 2013, commercialized by Microsoft Corporation, is also able to provide the same overall managerial functionalities. However, for that, their clients must pay for complementary programs. To be more specific, MPP 2013 does not provide two functionalities, portfolio management and document management system (table 3). Nevertheless, this drawback can be solved by installing the programs Project Server 2013 and Share Point 2013 respectively, which are sold separately from MPP 2013.

Redmine does not provide one of the essential functionalities that support an efficient project management, the critical path analysis function. Capabilities like milestones, resource allocation and budgeting, which are not provided by default, can be installed as plugins by the users for free.

ProjectLibre lacks two functionalities, which are required to implement an efficient management, namely, the Portfolio management and document management system (table 3).

The study developed under this dissertation allows to verify that, although the four selected software packages range between open source and proprietary, desktop and web-based application, they somehow cover the traditional management areas (section 3), that is, scheduling, resource allocation, costs and project control, areas that are essential for project management (Chen et al., 2006; Jaafari & Manivong, 1998). It is to be noticed that Redmine was included in this observation because it offers free plugins that allow specifically to manage these traditional areas.

As it was mentioned in section 3.3, it is the concerted level of collaboration that truly offers effective and efficient support for managing the complexities of a distributed project. At this level, all the team members must contribute in concert to the group efforts. Therefore, the performance of any team member influences the others members' performance (Chen et al., 2002; Romano et al., 2002).

Group Support System (GSS) is the commonly used technology to support the concerted level of collaboration (Nunamaker et al., 2002). The GSS can be defined as an information

technology specifically designed to provide structured process support for group meetings (Hayen et al., 2007; Munkvold & Anson, 2001).

The broader class of GSS technologies includes highly successful products such as WebDemo, Sametime, eRoom, Microsoft NetMeeting, Interwise, Groove, PlaceWare, WebEx and GroupSystems (Hayen et al., 2007; Munkvold & Anson, 2001).

Decision making is an important process within companies, policies, budget plans, and organizing tasks frequently involve group discussions or meetings. Therefore, it is easy to understand that several of the worldwide major corporations, with global groups, have invested significantly in GSS technology as in the case of American Airlines, Marriott, American Express, Boeing, Dupont, EDS, J.P. Morgan, IBM and Procter and Gamble (Hayen et al., 2007; Nunamaker et al., 2001).

With GSS greater productivity is achieved, since total meeting time is reduced and there is an increase in better decisions. Companies, such as IBM and Boeing, that have affiliates all over the world, have implemented these systems. As a consequence, there was a reduction of the meetings times and project times. The IBM has reduced meeting times by 56% and Boeing has reduced overall project times by over 90% (Hayen et al., 2007; Nunamaker et al., 2001). Thus, it becomes clear that the GSS technology allows team members collaborate and increases the effectiveness of decision making while reducing travel expenses (Hayen et al., 2007).

On one hand there has been a rapid increase in usage of CollabPMS, while on the other hand, the major corporations have largely invested in GSS systems. However, none of the four software packages already discussed have invested in GSS technology. As a consequence they don't support group problem solving and decision making (Chen et al., 2006; Nunamaker. et al., 2001). Therefore, ProjectLibre, Redmine, MPP 2013 and Clarizen do not support concerted work.

Redmine and Clarizen are both web-based software packages and have all by default the functionalities to address the coordinated level of collaboration (table 4); explicitly they have email, workflow automation and group calendar capabilities. In the coordinated level, the team success depends on the ability to coordinate efforts (see section 3.3). While Redmine offers all the capabilities of the coordinated work for free, in Clarizen it is required to pay, that is, it is needed to purchase the software. The MPP 2013, plus its third party applications as SharePoint

and Lync 2013, can also provide fully coordinated work to its users. But, for that the costumer must be willing to pay for the MPP 2013 and an extra for the SharePoint and Lync 2013. Both SharePoint and Lync 2013 are web-based applications.

Moreover ProjectLibre doesn't support any of the two collaboration levels. Because ProjectLibre doesn't present any collaborative functionality, it can be considered inadequate for managing distributed projects.

It is possible notice that collaboration in distributed projects needs somehow a web-based infrastructure; this observation supports the finds of Chen et al. (2006) that software packages with web interface are the ones that can fully support collaboration among dispersed team members.

Considering the price of each software package, there are two distinct groups: group 1- ProjectLibre and Redmine with free licensing and group 2 - MPP 2013 and Clarizen with paid licensing. It is possible to verify on table 3 and 4 that the Clarizen Incorporated is the only company able to provide by default a solution that fits into the majority of functionalities that we outlined. In the opposite side there is ProjectLibre, a free software package which lacks several of essential functionalities that we proposed. The study of Liberatore and Pollack-Johnson (2003) contributes somehow to this observation. According to them, high-end packages, that is, those software packages that are more expensive, tend to have more features capable of handling with huge and complex projects than the less expensive ones. They also state that larger firms are those that can usually afford more expensive PMS (Liberatore & Pollack-Johnson, 2003).

The author Romano et al. (2002) developed a study about CollabPMS and his conclusions were that most of the CollabPMS available at that time in the market just provided the lower levels of collaboration. For example, Microsoft Project 2000 which was one of the selected software packages by Romano, provided at that time the coordinated level of collaboration. Nowadays, the version of Microsoft Project 2013 (MPP 2013) still provides the coordinated level. In the past researchers had been proposed and developing CollabPMS prototypes to support concerted level (Chen et al., 2002; Romano et al., 2002). At the present, there is still the need to improve the software packages to provide concerted collaboration to companies who need it.

6. CONCLUSIONS AND FUTURE RESEARCH

Earlier in this dissertation the common problems of traditional project management paradigm were discussed. Together all these problems account for the reason why many distributed projects either fail or are significantly less efficient than they could be. The CollabPM includes some important factors that overcome the issues of traditional project management as: adequate communication and timely sharing of information in all directions, close project monitoring to enable effective proactive management and the existence of a document management system. Thus, CollabPM is the only paradigm capable of increasing the productivity and successful managing distributed projects.

It is possible to understand the positive impact that software tools have in project management versus handmade project management. It is extremely difficult, if not impossible to manage complex projects with extensive data and information without the help of PMS. The PMS tools play a broad role in managing projects; they can help on several complex functions such as scheduling, resource allocation, budget, project tracking and scenarios simulation. Moreover, the CollabPMS enables dispersed teams to work together in more efficient and effective ways than ever before, to successfully achieve the project's goal.

None of the four tested software packages have all the functionalities that we describe as ideal to support the implementation of distributed projects, because none of them provides the GSS functionality, and therefore they are not able to afford the concerted level of collaboration. As a result it is needed that these software packages and possibly the entire PMS market moves forward to provide a continuous collaboration among distributed team members. Nevertheless, in the overall scenario Clarizen can be considered the best software for managing distributed projects because it is the only one that, by default, provides all the outlined managerial functions and all the collaborative features that support the coordinated collaboration level. ProjectLibre was the software that performed the worst in this evaluation because of lack of support for any level of collaboration despite providing the majority of the outlined managerial functionalities.

My work is mainly based on literature review and most of the studies which I found and used date back between the 1990s till around 2006. As future work I would suggest create a

questionnaire to get an updated understanding of which features a CollabPMS should have to successfully deal with distributed projects. The goal of this survey would be gather the current expectations and real-life experiences of project managers about which are the features that are crucial for them when they have to deal with distributed projects. With the cooperation of Project Management Institute the questionnaire should be randomly sent to a sample of its project manager members.

This questionnaire should approach several issues like: (1) if they manage distributed projects and the kind of industry that they belong, (2) what software the project managers use, (3) using a scale from 0 to 10 classify the importance of the software functionalities, (3) what functionalities they would add to the software that they use.

The data provided from the survey can be used to:

A) Analyze if there is any correlation between distributed projects and the type of industry with the selection of PMS.

B) Develop at the conceptual level a CollabPMS with the generic capabilities and collaborative specifications that most of the project managers demanded on the survey. This conceptual prototype can be used as a benchmark CollabPMS for the study and ranking of the current CollabPMS available in the market.

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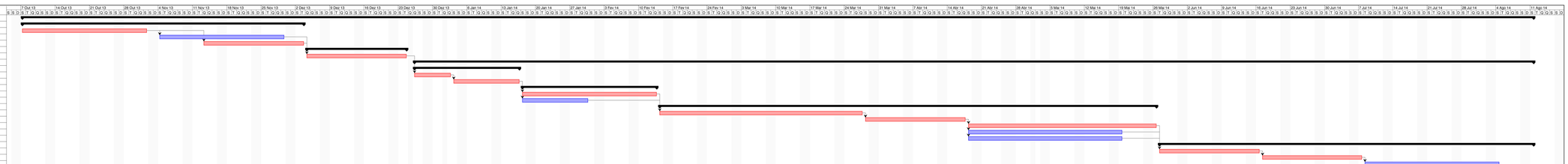
8. APPENDIXES

Appendix1 - Project´s Gantt Chart

	Nome	Duração	Início	Término	Predecessoras	Nome do Recurso
1	**BUILDING A FACTORY**	**217 dias**	**07-10-2013 8:00**	**11-08-2014 17:00**		
2	**Factory building plans**	**42 dias**	**07-10-2013 8:00**	**03-12-2013 17:00**		
3	Facility layout	20 dias	07-10-2013 8:00	01-11-2013 17:00		
4	Architectural design	20 dias	04-11-2013 8:00	29-11-2013 17:00	3	
5	Technical plan	15 dias	13-11-2013 8:00	03-12-2013 17:00	3TI+7 dias	
6	**Construction approval**	**15 dias**	**04-12-2013 8:00**	**24-12-2013 17:00**		
7	Building permit	15 dias	04-12-2013 8:00	24-12-2013 17:00	4,5	
8	**Construction Stage**	**160 dias**	**26-12-2013 8:00**	**11-08-2014 17:00**		
9	**Site Preparation**	**15 dias**	**26-12-2013 8:00**	**16-01-2014 17:00**		
10	Land grading	5 dias	26-12-2013 8:00	02-01-2014 17:00	7	
11	Excavations & Trenching	10 dias	03-01-2014 8:00	16-01-2014 17:00	10	
12	**Initial structure**	**20 dias**	**17-01-2014 8:00**	**13-02-2014 17:00**		
13	Foundations	20 dias	17-01-2014 8:00	13-02-2014 17:00	11	
14	Laying the pipes	10 dias	17-01-2014 8:00	30-01-2014 17:00	11	
15	**Light steel framing and rough ins**	**70 dias**	**14-02-2014 8:00**	**26-05-2014 17:00**		
16	Assembly the metalic structures	30 dias	14-02-2014 8:00	27-03-2014 17:00	13;14	
17	Roof	15 dias	28-03-2014 8:00	17-04-2014 17:00	16	
18	Coating the metalic structures	25 dias	18-04-2014 8:00	26-05-2014 17:00	17	
19	Electrical work	20 dias	18-04-2014 8:00	19-05-2014 17:00	17	
20	Plumbing	20 dias	18-04-2014 8:00	19-05-2014 17:00	17	
21	**Finishing works**	**55 dias**	**27-05-2014 8:00**	**11-08-2014 17:00**		
22	Install the flooring	15 dias	27-05-2014 8:00	16-06-2014 17:00	18;19;20	
23	Interior partitions - office section	15 dias	17-06-2014 8:00	07-07-2014 17:00	22	
24	Interior painting	20 dias	08-07-2014 8:00	04-08-2014 17:00	23	
25	Exterior painting	25 dias	08-07-2014 8:00	11-08-2014 17:00	23	



		Nome	Duração	Início	Término	Predecessoras	Nome do Recurso
1		**BUILDING A FACTORY**	**217 dias**	**07-10-2013 8:00**	**11-08-2014 17:00**		
2		Beguin of the project	0 dias	07-10-2013 8:00	07-10-2013 8:00		
3		**Factory building plans**	**42 dias**	**07-10-2013 8:00**	**03-12-2013 17:00**		
4		Facility layout	20 dias	07-10-2013 8:00	01-11-2013 17:00		
5		Architectural design	20 dias	04-11-2013 8:00	29-11-2013 17:00	4	
6		Technical plan	15 dias	13-11-2013 8:00	03-12-2013 17:00	4TI+7 dias	
7		Factory building plans completed	0 dias	03-12-2013 9:00	03-12-2013 9:00		
8		**Construction approval**	**15 dias**	**04-12-2013 8:00**	**24-12-2013 17:00**		
9		Building permit	15 dias	04-12-2013 8:00	24-12-2013 17:00	5;6	
10		Building permit granted	0 dias	24-12-2013 9:00	24-12-2013 9:00		
11		**Construction Stage**	**160 dias**	**26-12-2013 8:00**	**11-08-2014 17:00**		
12		**Site Preparation**	**15 dias**	**26-12-2013 8:00**	**16-01-2014 17:00**		
13		Land grading	5 dias	26-12-2013 8:00	02-01-2014 17:00	9	
14		Excavations & Trenching	10 dias	03-01-2014 8:00	16-01-2014 17:00	13	
15		Ground ready to build	0 dias	16-01-2014 9:00	16-01-2014 9:00		
16		**Initial structure**	**20 dias**	**17-01-2014 8:00**	**13-02-2014 17:00**		
17		Foundations	20 dias	17-01-2014 8:00	13-02-2014 17:00	14	
18		Laying the pipes	10 dias	17-01-2014 8:00	30-01-2014 17:00	14	
19		Initial structural phase closed	0 dias	13-02-2014 9:00	13-02-2014 9:00		
20		**Light steel framing and rough ins**	**70 dias**	**14-02-2014 8:00**	**26-05-2014 17:00**		
21		Assembly the metallic structures	30 dias	14-02-2014 8:00	27-03-2014 17:00	17;18	
22		Roof	15 dias	28-03-2014 8:00	17-04-2014 17:00	21	
23		Coating the metallic structures	25 dias	18-04-2014 8:00	26-05-2014 17:00	22	
24		Electrical work	20 dias	18-04-2014 8:00	19-05-2014 17:00	22	
25		Plumbing	20 dias	18-04-2014 8:00	19-05-2014 17:00	22	
26		Light steel framing and rough ins con...	0 dias	26-05-2014 8:00	26-05-2014 8:00		
27		**Finishing works**	**55 dias**	**27-05-2014 8:00**	**11-08-2014 17:00**		
28		Install the flooring	15 dias	27-05-2014 8:00	16-06-2014 17:00	23;24;25	
29		Interior partitions - office section	15 dias	17-06-2014 8:00	07-07-2014 17:00	28	
30		Interior painting	20 dias	08-07-2014 8:00	04-08-2014 17:00	29	
31		Exterior painting	25 dias	08-07-2014 8:00	11-08-2014 17:00	29	
32		Project accomplished_Construction com...	0 dias	11-08-2014 8:00	11-08-2014 8:00		

Appendix3 - Resources Allocation

		Nome	Duração	Início	Término	Predecessoras	Nome do Recurso
1		**BUILDING A FACTORY**	**217 dias**	**07-10-2013 8:00**	**11-08-2014 17:00**		
2		Beguin of the project	0 dias	07-10-2013 8:00	07-10-2013 8:00		
3		**Factory building plans**	**42 dias**	**07-10-2013 8:00**	**03-12-2013 17:00**		
4		Facility layout	20 dias	07-10-2013 8:00	01-11-2013 17:00		Industrial Engineer [50%];A...
5		Architectural design	20 dias	04-11-2013 8:00	29-11-2013 17:00	4	Industrial Engineer [50%];A...
6		Technical plan	15 dias	13-11-2013 8:00	03-12-2013 17:00	4TI+7 dias	Civil Engineer
7		Factory building plans completed	0 dias	03-12-2013 9:00	03-12-2013 9:00		
8		**Construction approval**	**15 dias**	**04-12-2013 8:00**	**24-12-2013 17:00**		
9		Building permit	15 dias	04-12-2013 8:00	24-12-2013 17:00	5;6	Civil Engineer
10		Building permit granted	0 dias	24-12-2013 9:00	24-12-2013 9:00		
11		**Construction Stage**	**160 dias**	**26-12-2013 8:00**	**11-08-2014 17:00**		
12		**Site Preparation**	**15 dias**	**26-12-2013 8:00**	**16-01-2014 17:00**		
13		Land grading	5 dias	26-12-2013 8:00	02-01-2014 17:00	9	Foreman[50%];Grader Ope...
14		Excavations & Trenching	10 dias	03-01-2014 8:00	16-01-2014 17:00	13	Foreman;Construction Work...
15		Ground ready to build	0 dias	16-01-2014 9:00	16-01-2014 9:00		
16		**Initial structure**	**20 dias**	**17-01-2014 8:00**	**13-02-2014 17:00**		
17		Foundations	20 dias	17-01-2014 8:00	13-02-2014 17:00	14	Civil Engineer[50%];Forema...
18		Laying the pipes	10 dias	17-01-2014 8:00	30-01-2014 17:00	14	Civil Engineer[50%];Forema...
19		Initial structural phase closed	0 dias	13-02-2014 9:00	13-02-2014 9:00		
20		**Light steel framing and rough ins**	**70 dias**	**14-02-2014 8:00**	**26-05-2014 17:00**		
21		Assembly the metallic structures	30 dias	14-02-2014 8:00	27-03-2014 17:00	17;18	Civil Engineer[50%];Forema...
22		Roof	15 dias	28-03-2014 8:00	17-04-2014 17:00	21	Civil Engineer[50%];Forema...
23		Coating the metallic structures	25 dias	18-04-2014 8:00	26-05-2014 17:00	22	Civil Engineer[50%];Forema...
24		Electrical work	20 dias	18-04-2014 8:00	19-05-2014 17:00	22	Electrician[200%];Electricia...
25		Plumbing	20 dias	18-04-2014 8:00	19-05-2014 17:00	22	Plumber[200%];Plumber Hel...
26		Light steel framing and rough ins con...	0 dias	26-05-2014 8:00	26-05-2014 8:00		
27		**Finishing works**	**55 dias**	**27-05-2014 8:00**	**11-08-2014 17:00**		
28		Install the flooring	15 dias	27-05-2014 8:00	16-06-2014 17:00	23;24;25	Foreman;Construction Work...
29		Interior partitions - office section	15 dias	17-06-2014 8:00	07-07-2014 17:00	28	Foreman;Construction Work...
30		Interior painting	20 dias	08-07-2014 8:00	04-08-2014 17:00	29	Painter;Painter Helper
31		Exterior painting	25 dias	08-07-2014 8:00	11-08-2014 17:00	29	Painter;Painter Helper
32		Project accomplished_Construction com...	0 dias	11-08-2014 8:00	11-08-2014 8:00		

Appendix 4 - Best Simulation

		Nome	Duração	Início	Término	Predecessoras	Nome do Recurso
1		**BUILDING A FACTORY**	**212 dias**	**07-10-2013 8:00**	**04-08-2014 17:00**		
2		Beguin of the project	0 dias	07-10-2013 8:00	07-10-2013 8:00		
3		**Factory building plans**	**42 dias**	**07-10-2013 8:00**	**03-12-2013 17:00**		
4		Facility layout	20 dias	07-10-2013 8:00	01-11-2013 17:00		Industrial Engineer [50%];A...
5		Architectural design	20 dias	04-11-2013 8:00	29-11-2013 17:00	4	Industrial Engineer [50%];A...
6		Technical plan	15 dias	13-11-2013 8:00	03-12-2013 17:00	4TI+7 dias	Civil Engineer
7		Factory building plans completed	0 dias	03-12-2013 9:00	03-12-2013 9:00		
8		**Construction approval**	**15 dias**	**04-12-2013 8:00**	**24-12-2013 17:00**		
9		Building permit	15 dias	04-12-2013 8:00	24-12-2013 17:00	5;6	Civil Engineer
10		Building permit granted	0 dias	24-12-2013 9:00	24-12-2013 9:00		
11		**Construction Stage**	**155 dias**	**26-12-2013 8:00**	**04-08-2014 17:00**		
12		**Site Preparation**	**15 dias**	**26-12-2013 8:00**	**16-01-2014 17:00**		
13		Land grading	5 dias	26-12-2013 8:00	02-01-2014 17:00	9	Foreman[50%];Grader Ope...
14		Excavations & Trenching	10 dias	03-01-2014 8:00	16-01-2014 17:00	13	Foreman;Construction Work...
15		Ground ready to build	0 dias	16-01-2014 9:00	16-01-2014 9:00		
16		**Initial structure**	**20 dias**	**17-01-2014 8:00**	**13-02-2014 17:00**		
17		Foundations	20 dias	17-01-2014 8:00	13-02-2014 17:00	14	Civil Engineer[50%];Forema...
18		Laying the pipes	10 dias	17-01-2014 8:00	30-01-2014 17:00	14	Civil Engineer[50%];Forema...
19		Initial structural phase closed	0 dias	13-02-2014 9:00	13-02-2014 9:00		
20		**Light steel framing and rough ins**	**70 dias**	**14-02-2014 8:00**	**26-05-2014 17:00**		
21		Assembly the metallic structures	30 dias	14-02-2014 8:00	27-03-2014 17:00	17;18	Civil Engineer[50%];Forema...
22		Roof	15 dias	28-03-2014 8:00	17-04-2014 17:00	21	Civil Engineer[50%];Forema...
23		Coating the metallic structures	25 dias	18-04-2014 8:00	26-05-2014 17:00	22	Civil Engineer[50%];Forema...
24		Electrical work	20 dias	18-04-2014 8:00	19-05-2014 17:00	22	Electrician[200%];Electricia...
25		Plumbing	20 dias	18-04-2014 8:00	19-05-2014 17:00	22	Plumber[200%];Plumber Hel...
26		Light steel framing and rough ins con...	0 dias	26-05-2014 8:00	26-05-2014 8:00		
27		**Finishing works**	**50 dias**	**27-05-2014 8:00**	**04-08-2014 17:00**		
28		Install the flooring	15 dias	27-05-2014 8:00	16-06-2014 17:00	23;24;25	Foreman;Construction Work...
29		Interior partitions - office section	15 dias	17-06-2014 8:00	07-07-2014 17:00	28	Foreman;Construction Work...
30		Interior painting	20 dias	08-07-2014 8:00	04-08-2014 17:00	29	Painter;Painter Helper
31		Exterior painting	25 dias	03-06-2014 8:00	07-07-2014 17:00	29TT	Painter;Painter Helper
32		Project accomplished_Construction com...	0 dias	04-08-2014 8:00	04-08-2014 8:00		

Who Does What

ID Recurso	Recurso
1	**Industrial Engineer**

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término
5	Architectural design	80 horas	50%	0 dias	04-11-2013 8:00	29-11-2013 17:00
4	Facility layout	80 horas	50%	0 dias	07-10-2013 8:00	01-11-2013 17:00
		160 horas				

ID Recurso	Recurso
2	**Architect**

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término
4	Facility layout	80 horas	50%	0 dias	07-10-2013 8:00	01-11-2013 17:00
5	Architectural design	80 horas	50%	0 dias	04-11-2013 8:00	29-11-2013 17:00
		160 horas				

ID Recurso	Recurso
3	**Civil Engineer**

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término
18	Laying the pipes	40 horas	50%	0 dias	17-01-2014 8:00	30-01-2014 17:00
21	Assembly the metallic structures	120 horas	50%	0 dias	14-02-2014 8:00	27-03-2014 17:00
6	Technical plan	120 horas	100%	0 dias	13-11-2013 8:00	03-12-2013 17:00
9	Building permit	120 horas	100%	0 dias	04-12-2013 8:00	24-12-2013 17:00
23	Coating the metallic structures	100 horas	50%	0 dias	18-04-2014 8:00	26-05-2014 17:00
17	Foundations	80 horas	50%	0 dias	17-01-2014 8:00	13-02-2014 17:00
22	Roof	60 horas	50%	0 dias	28-03-2014 8:00	17-04-2014 17:00
		640 horas				

ID Recurso	Recurso
4	**Foreman**

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término

ID Recurso	Recurso					
13	Land grading	20 horas	50%	0 dias	26-12-2013 8:00	02-01-2014 17:00
14	Excavations & Trenching	80 horas	100%	0 dias	03-01-2014 8:00	16-01-2014 17:00
29	Interior partitions - office section	120 horas	100%	0 dias	17-06-2014 8:00	07-07-2014 17:00
23	Coating the metallic structures	200 horas	100%	0 dias	18-04-2014 8:00	26-05-2014 17:00
17	Foundations	80 horas	50%	0 dias	17-01-2014 8:00	13-02-2014 17:00
28	Install the flooring	120 horas	100%	0 dias	27-05-2014 8:00	16-06-2014 17:00
22	Roof	120 horas	100%	0 dias	28-03-2014 8:00	17-04-2014 17:00
18	Laying the pipes	40 horas	50%	0 dias	17-01-2014 8:00	30-01-2014 17:00
21	Assembly the metallic structures	240 horas	100%	0 dias	14-02-2014 8:00	27-03-2014 17:00
		1.020 horas				

5 Construction Worker

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término
22	Roof	360 horas	300%	0 dias	28-03-2014 8:00	17-04-2014 17:00
28	Install the flooring	240 horas	200%	0 dias	27-05-2014 8:00	16-06-2014 17:00
18	Laying the pipes	80 horas	100%	0 dias	17-01-2014 8:00	30-01-2014 17:00
21	Assembly the metallic structures	720 horas	300%	0 dias	14-02-2014 8:00	27-03-2014 17:00
29	Interior partitions - office section	240 horas	200%	0 dias	17-06-2014 8:00	07-07-2014 17:00
14	Excavations & Trenching	80 horas	100%	0 dias	03-01-2014 8:00	16-01-2014 17:00
23	Coating the metallic structures	600 horas	300%	0 dias	18-04-2014 8:00	26-05-2014 17:00
17	Foundations	480 horas	300%	0 dias	17-01-2014 8:00	13-02-2014 17:00
		2.800 horas				

6 Grader Operator

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término
13	Land grading	40 horas	100%	0 dias	26-12-2013 8:00	02-01-2014 17:00
		40 horas				

ID Recurso	Recurso
7	**Backoe Operator**

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término
14	Excavations & Trenching	80 horas	100%	0 dias	03-01-2014 8:00	16-01-2014 17:00
		80 horas				

ID Recurso	Recurso
8	**Crane Operator**

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término
23	Coating the metallic structures	200 horas	100%	0 dias	18-04-2014 8:00	26-05-2014 17:00
21	Assembly the metallic structures	240 horas	100%	0 dias	14-02-2014 8:00	27-03-2014 17:00
22	Roof	120 horas	100%	0 dias	28-03-2014 8:00	17-04-2014 17:00
17	Foundations	160 horas	100%	0 dias	17-01-2014 8:00	13-02-2014 17:00
		720 horas				

ID Recurso	Recurso
9	**Electrician**

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término
18	Laying the pipes	80 horas	100%	0 dias	17-01-2014 8:00	30-01-2014 17:00
24	Electrical work	320 horas	200%	0 dias	18-04-2014 8:00	19-05-2014 17:00
		400 horas				

ID Recurso	Recurso
10	**Electrician Helper**

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término
24	Electrical work	320 horas	200%	0 dias	18-04-2014 8:00	19-05-2014 17:00
18	Laying the pipes	0,634 horas	200%	0 dias	17-01-2014 8:00	17-01-2014 8:19
		320,634 horas				

ID Recurso	Recurso
11	**Plumber**

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término

ID Recurso	Recurso					
25	Plumbing	320 horas	200%	0 dias	18-04-2014 8:00	19-05-2014 17:00
18	Laying the pipes	80 horas	100%	0 dias	17-01-2014 8:00	30-01-2014 17:00
		400 horas				

12 Plumber Helper

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término
18	Laying the pipes	160 horas	200%	0 dias	17-01-2014 8:00	30-01-2014 17:00
25	Plumbing	320 horas	200%	0 dias	18-04-2014 8:00	19-05-2014 17:00
		480 horas				

13 Painter

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término
30	Interior painting	160 horas	100%	0 dias	08-07-2014 8:00	04-08-2014 17:00
31	Exterior painting	200 horas	100%	0 dias	03-06-2014 8:00	07-07-2014 17:00
		360 horas				

14 Painter Helper

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término
31	Exterior painting	200 horas	100%	0 dias	03-06-2014 8:00	07-07-2014 17:00
30	Interior painting	160 horas	100%	0 dias	08-07-2014 8:00	04-08-2014 17:00
		360 horas				

15 Grader

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término
13	Land grading	1	100%	0 dias	26-12-2013 8:00	02-01-2014 17:00
		0 horas				

ID Recurso	Recurso
16	**Backhoe**

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término
14	Excavations & Trenching	1	100%	0 dias	03-01-2014 8:00	16-01-2014 17:00
		0 horas				

ID Recurso	Recurso
17	**Crane**

ID Tarefa	Tarefa	Trabalho	Unidades Atribuídas	Atraso da	Início	Término
23	Coating the metallic structures	1	100%	0 dias	18-04-2014 8:00	26-05-2014 17:00
22	Roof	1	100%	0 dias	28-03-2014 8:00	17-04-2014 17:00
17	Foundations	1	100%	0 dias	17-01-2014 8:00	13-02-2014 17:00
21	Assembly the metallic structures	1	100%	0 dias	14-02-2014 8:00	27-03-2014 17:00
		0 horas				