WebPro: an easy-to-use accessible web-based project administration system

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Abstract

Administering complex research projects entails considerable effort especially for sharing a common understanding of project goals and for timely monitoring of progress. Additional difficulties may be encountered if project members are distributed in different geographical locations and speak different languages. One approach to the solution of this problem is the use of specialised on-line tools. Several existing project management tools have been reviewed to analyse the extent of assistance offered to project members. For the majority of the project stakeholders, existing tools appear rather complicated to use and difficult to learn. Based upon our findings, an interactive, user-friendly and accessible web-based application has been designed and implemented to support on-line project administration, through a set of easy-to-learn and easy-to-use facilities. WebPro provides facilities to project members, according to their role in the project and the assigned tasks. The evaluation of WebPro has confirmed that it improves specific aspects of project administration tasks, by facilitating a higher degree of user interaction; it is user-friendly, by offering possibilities for overall reduction of the time required for the accomplishment of certain project tasks and it is accessible by people with disabilities, by complying with WCAG 1.0 Level A guidelines.
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1. BACKGROUND INFORMATION QUESTIONNAIRE
2. INTERACTION SCENARIOS
3. QUESTIONNAIRES
1 Introduction

Modern organizations and research institutes organize their work in the form of projects. Each project comprises a number of participants with different roles and responsibilities. The project manager is the main actor and the head of the team participants’ hierarchy. Project management entails considerable effort especially regarding sharing a common understanding of the project goals with the project team, as well as the timely monitoring of the project’s progress. At the same time, managers should have organizational and interpersonal communication skills in order to form a productive working team that have the required skills to deal with the project goals but also the possibility to work together effectively and efficiently. Furthermore, communication between manager and project members should be carried out with respect of each member’s characteristics in order to avoid conflicts within the team. All the above efforts must focus on achieving the main goal which is the completion of the project within time and budget.

Another aspect identified in modern organizations is the cooperation of participants in the context of a project from different geographical locations. This happens especially within multinational organizations that undertake world wide research or development projects. The difficulties that arise from such organizational status can be identified as lack of interpersonal communication, problematic cooperation of parties, communication problems due to different languages, difficulties in the creation of project deliverables acceptable by all parties and last but not least manager control over the project participants.

Much research has been conducted to address the above difficulties and several approaches have been put forward. The most popular approach proposed by computer scientists recommends the use of specialized project administration tools. The creation of such specialized tools is facilitated by the evolution of internet technology and by the emergence of new techniques for interpersonal communications, such as on-line chats, message boards and email facilities that offer alternative ways of communication in the computerized environment.

Although great effort has been put in the creation of tools that provide the aforementioned facilities, there are still several issues that need to be addressed, in particular concerning the usefulness, usability, and user-friendliness of support tools. For example, many of the available project administration tools are complicated to use and difficult to learn.

This technical report describes a novel project management tool, named WebPro, supporting all the aspects of project organization, implementation and supervision, based on an in-depth analysis of the related user requirements. The proposed system addresses a wide variety of users, including managers, middle managers and simple users, fostering collaboration and communication between them through the provision of appropriate mechanisms. Furthermore, the system offers the appropriate facilities to all members, and especially to project managers, for project administration, allocation and monitoring of funds, and administration of members.

The structure of this report reflects the user based design approach that was adopted for the creation of WebPro. Section 2 discusses related work, and aims at identifying potential pitfalls and drawbacks as well as potential useful mechanisms and facilities.
in existing systems while section 3 reports on the design and implementation of
WebPro system, discussing all the related phases. Section 4 presents the available
functionality and the user interface of WebPro, highlighting the added benefits of
using the system in project management. Section 5 reports the results of the usability
evaluation of WebPro and finally section 6 presents the conclusions of the reported
work.
2 Related Work

2.1 Project Management

The evolution of project management is originated from the work done in large scale military systems. These systems required an organized approach in order to manage the complex interrelationships among an enormous number of different tasks performed by a variety of different specialists. Kerzner [1] defines project management as “the planning, organizing, directing, and controlling of company resources for a relatively short-term objective that has been established to complete specific goals and objectives”. Project management entails all the stages of a project, namely, initiation, scheduling, realization, evaluation and completion (see Figure 2-1).

During this process several stakeholders are involved, including a project manager and the project team. The main duty of the project manager is to identify project’s tasks, allocate the identified workload to project team members, guide them towards the completion of their work, assure the quality of the deliverables, and evaluate the intermediate and final results according to project’s goals, budget and time schedule. Correspondingly, members of the team, are responsible for undertaking specific tasks and subtasks of a project, following manager’s directions and reporting the results of their work.

The success of the project depends to a large extent on the competence and expertise of the project manager and of the team members. The project manager, as the main responsible for the advancement of the project, should be able to organize, allocate, inspect, assist, correct and evaluate the work of the project team. Such a demanding process requires several capabilities, such as, for example, the ability to communicate with the other members of the team and the clients, to concentrate on each activity of the project and to be able to appropriately react to deviations from project goals or time schedule. In particular, the role of communication in the project life-cycle is of paramount importance since members of the project team communicate with a variety of synchronous and asynchronous means: conversations, discussions, brainstorming, meetings and consultations, as well as exchanging messages, opinions and news. Communication problems during the life-cycle of a project may have severe consequences on the project’s outcomes. Therefore, these problems have to be timely identified, analyzed and solved, and the ability to communicate using various communication styles emerges as one of the most important skills of a project manager.

The fundamental objectives of project management are defined as follows [2]:

- to “get the job done”, and
- to attain the objectives of the project within:
  - scheduled time,
  - expected cost, and
  - with predefined performance.

These three targets provide the focal point for all project management efforts and require attention and energy on the part of the project manager. They also set the constraints within which project management operates, and are sometimes referred to as a triple constraint [2]. The challenge of project management lies in finding a
balance among these constraints and to provide appropriate means for their satisfaction.

A fourth constraint often mentioned in literature concerns good client relations [2]. According to this, the ultimate measure of project success is the client. If in the process of meeting the three critical dimensions the manager or the project staff alienates from the client, the project fails. A project can be considered successful only if the client, whether it is a group of internal users or a client in another company, is satisfied with the results. Client interaction is particularly important for information systems (IS) projects.

The above analysis made clear that the process of project management entails many risks for the success of a project. Among the management-related risks the following are the most frequently cited in the project management literature [2]:

- Poorly defined goals and specifications;
- Lack or insufficiency of project plan;
- Unrealistic deadlines and budgets;
- Lack of communication between project members’ team and between clients.

Although some projects fail for technical reasons, most failures are caused by people who ignore the principles of good project management.

## 2.2 Software tools for project administration

With the objective to address the risks, difficulties and complexity concerning project management, many project administration tools have been developed nowadays, providing assistance to all the project participants. These tools aim to aid project stakeholders to complete a project successfully. The main advantages of such tools are discussed in the following paragraphs.

The majority of the tools claims that they reduce the managerial workload of project managers by facilitating the distribution of tasks and improving the reporting process by providing real-time information about project activities including status, progress and open issues. They also provide visualization of project activities, and as a consequence more opportunities to project managers to identify and deal with potential problems, saving time and reducing managerial coordination and communication overhead.

Apart from the benefits for project managers, there are also several benefits for the team members. The tools usually provide personalized document folders and work areas as well as mechanisms to log personal comments and document the hours of work. Other available facilities allow team members to easily access, share and collaborate on various tasks and documents. Thus, time is saved by boosting personal and team productivity as well as self-confidence through the available facilities and mechanisms.

There are several tools that claim that they assist the administration of a project. A thorough review of such systems has been performed to identify their advantages and disadvantages and analyze their usability and usefulness.
### 2.3 Project management systems’ general characteristics

A review of several existing project management systems was performed to identify the key characteristics of such systems and to analyze their advantages and disadvantages. Particular attention has been paid to usability analysis of the existing systems identifying the major usability problems of each of them. The analysis of the systems showed that commercially available project management tools can be divided in two main categories in terms of the supported computer platform: desktop applications and web–based tools.

Desktop applications can be further subdivided in spreadsheet applications and standard windows applications. Spreadsheet-based applications mainly provide means to manage task deadlines, task budget and numerical data, and in some cases they also facilitate the human resource management requirements of a project. The absence of advanced functions such as communication facilities or individual work areas appears as a major disadvantage of this tools’ category.
2.3.1 Spreadsheet-based applications

An example of spreadsheet-based application is StgCost [3]. This tool provides several fields where project managers can fill in project related information such as project and task deadlines, estimated budget and assigned users. With the help of macro commands, the application can make calculations based on the existing information. The main advantage of the system is that it can be quite helpful for engineering calculations and statistics. Furthermore, StgCost is relatively easy to setup, modify and use, since it is possible to change one variable, and immediately see the effect on all the interconnected variables of the spreadsheet.

However, there are several disadvantages in spreadsheet applications that are also evident in StgCost. First of all, there are limited possibilities to perform design calculations. This term is used to describe a procedure where users perform a calculation in a series of logical steps. In that way users feel that they perform the requested function in the same way they would have done if they didn’t use an automated system. For example, in order to calculate the total hours of work for a specific user in a spreadsheet application, a macro should be called that produces the requested calculation. On the contrary, design calculation requires a series of actions where the user first chooses the desired employee, then sets the time period and finally computes the sum of hours. The latter process is exactly the same as in the case of manual calculation, and arguably makes the user of the system feel more comfortable with respect to spreadsheet applications.

Another similar problem identified in spreadsheet applications is that the original equations used to perform the calculations are not displayed, and, as a consequence, the automated printed report becomes illegible. Even in an on-line version of a spreadsheet, it is difficult to read and verify a long equation that calculates a result. Thus, there are certain difficulties for the user to verify and check the results of the calculations performed with a spreadsheet application such as StgCost.

Apart from calculation related problems, several usability problems can also be identified. StgCost and in general all the systems based on the spreadsheet metaphor require that the users are already experienced in using such applications and thus do not provide adequate assistance and guidance to novice users. Furthermore, these applications are built on the basis of a generic spreadsheet framework, which includes several other functions that are not useful in the specific context of project administration and sometimes constitute a overhead to end-users.

Another basic usability problem can be considered the fact that in spreadsheet applications new functions are added to alter the existing and straightforward spreadsheet functionality according to the needs of the project management application. Spreadsheets were originally created in order to transfer the forms used in traditional workspaces into electronic forms in a personal computer. As new functions were added to the spreadsheet metaphor, it became more difficult for users to understand and work with the new complex functionality.

Finally, another important aspect that must be considered is the lack of graphical representation of the available information, which could provide useful visual clues...
concerning project status. Finally, as noted for all the spreadsheet tools, “StgCost” does not also provide mechanisms for interpersonal communication, acting only as a tool for monitoring various project parameters and can be used mainly by project managers.

2.3.2 Windows applications

The objective of windows project management applications is to provide managers with the means to organize and manage a project. These applications offer more advantages with respect to spreadsheet applications, such as a wide variety of graphical representations for project overview and statistics, algorithms for cost estimation, risk management and quick insertion of data with the help, however, of spreadsheet functionality. Furthermore, these systems often provide managers with the appropriate mechanisms to organize their working time using calendar components and notification services.

Nevertheless, this type of tools has two main disadvantages. Most applications do not provide communication facilities for project members, and as a result there are difficulties in team organization and member intercommunication. Additionally, in many cases these systems require a certain amount of training in order for the end user to complete advanced tasks.

A representative application of this category is the Plan Bee project management tool [4]. Plan Bee is a desktop tool that uses a spreadsheet mechanism to gather and display relevant project data. Through a variety of graphical representations, including Gantt charts and schedule networks, it provides useful information on the project status and ongoing processes. The tool also provides useful mechanisms such as personal and project calendar, cost estimation procedures and an automatic report generation mechanism. Finally, another important feature that assists the management of a complex project is the possibility of creating a project tasks’ decomposition hierarchy with arbitrary depth.

However, there are essential disadvantages of Plan Bee especially concerning the usability of its user interface, as depicted in Figure 2-2. For example, the colour-coding that is used in order to identify the basic parts of interest results in screen pollution by several different colours (colour pollution usability problem). Another problem that can be easily identified is the existence of several pop-up windows that confuse users and make interaction more difficult. Concerning functionality, the lack of communication facilities between project members creates the impression that the goal of Plan Bee is mainly to give managers an efficient way to manage their projects in an individual rather than in a team-based manner.
2.3.3 Web-based tools

Examples of web-based tools are Ace Project [5], Double chocolate [6], and Xcolla [7]. Ace Project is an online planning tool that allows users to manage any type of projects within their organization (see Figure 2-3). It offers a useful timesheet module, a project calendar facility and an email notification service that are basically used to achieve interpersonal communication between the project members. Furthermore, it provides several graphical representations such as Gantt charts that provide project overview, status etc. Last but not least, “ace project” users have the ability to access several project statistics for monitoring the basic aspects of each task.

However, Ace Project, apart from several useful features, also has certain disadvantages. First of all, the system is based on a form filling metaphor in order to complete most of the tasks. This process can be quite annoying for the end-user especially for performing simple operations such as results filtering. On the other hand, several improvements can be made on the communication mechanisms of the system since only a message board and an email notification service are provided. These features can be effective for asynchronous communication but the requirements of the team members demand also synchronous communication facilities. In addition, an important disadvantage is the absence of graphical representation for the project statistics. Finally, the existing documents area has only a single directory for all the project documents, which does not fulfill the requirements for a hierarchical organization of project’s documents.
Double Chocolate, on the other hand, is an open source project management tool that offers functionality for administrating projects and tasks (Figure 2-4). It allows the decomposition of a project in n–levels of tasks and subtasks, facilitating the organizational management of the project and personnel. The communication between the manager and project members is established through reminders that notify each user on expiration. Furthermore, managers can perform various tasks regarding the administration of their project or team using the relevant administration functionality.

Nevertheless, many disadvantages can be identified in Double Chocolate. The basic problem identified in “double chocolate” is that the users cannot understand how the system works, or what action they must perform in order to complete a task, due to the fact that it does not offer online help and does not include explanations and descriptions on how a user could complete a task. Another serious problem is that the system doesn’t provide a general overview of all the projects in which the user participates. The same applies to managers, since they have to search and find a specific project in order to monitor its status or manage it. Furthermore, the communication facilities provided by the system do not offer all the required functionality, but only asynchronous notifications. Finally, other components, such as document areas and personal work spaces, are completely absent. As a result of these drawbacks, “double chocolate” is basically a tool assisting the manager to monitor a project and not a tool for helping the whole project team to work efficiently and effectively.
Xcolla is another web tool with the ambition to provide team members across an organization with a comprehensive and easy-to-use environment for managing projects (Figure 2-5). It offers several facilities, such as reportable project deliverables, task status overviews, Gantt charts, a journal to track personal work and time, document management, project overview charts, group and personal calendar. The tool also provides different access rights to the members of the project team.

Xcolla lacks communication facilities having only email notifications. Other identified problems of the tool are the lack of graphical or text representation of related statistics. Finally, the access rights’ mechanism does not provide a unified authorisation technique for all team members, based on user roles. Each team member can have different access rights for a specific resource. This approach might seem flexible, but in the end, users become confused especially in cases where a project manager does not have access to a document while simple users may have.

Figure 2-4: Double Chocolate System
2.3.4 Functionality and usability issues for Project management tools

The above analysis revealed the existence of many functionality and usability problems concerning existing project management systems, which however may not be evident to inexperienced users. The next sections will discuss functionality and usability issues that should be taken into account for a successful online project management system as these emerge from the analysis of the existent systems.

- **Functionality Issues.** This category contains mechanisms and tools that in general are absent in the majority of the available systems.

- **Usability Issues.** This category is mainly concerned with problems in the interaction process, difficulties in understanding system functions and problems that occur as a result of bad decisions during the system design phase of the analysed systems.

**Functionality Issues**

The analysis of project management in the previous sections shows that project managers should know about the existence of appropriate and available resources, since getting the right people involved in a project drastically improves the chances for success. For example, a developer might be very talented and experienced, but not appropriate for a collaborative task, if the specific person prefers to work individually and not within a team. Of course, it is not expected that the system could make decisions instead of the project manager, but it could provide some clues, e.g., candidate member profile, that can help the project manager to make the right decisions for appointing a project team.
Another issue is that the project manager is responsible for carrying out demanding operations such as the communication with the project team and the administration of project funds and human resources. These operations, in order to be carried out efficiently in the context of a web based tool, demand the existence of specialized mechanisms that support such tasks. The most important fact that must be considered in order to address the communication issues is that people communicate in a wide variety of ways, such as direct or indirect, formal or informal communication, etc. Thus, diverse means of communication should be supported by a web based project administration tool.

Another important issue in project management is the administration of project funds. This function is necessary in order to provide a prediction about how feasible the completion of each project is within the planned budget and time. Moreover, a mechanism that provides the necessary information about the workload of each employee and the resources needed in order to complete each task is necessary for monitoring the feasibility of a project. All these functions must be provided through various graphical representations, making visible the most important aspects in alternative forms.

Finally, a crucial aspect for the success of such a supporting system is the existence of error prevention mechanisms and powerful help facilities. Since project management applications contain much information and often require complex and crucial actions, it is necessary for the system to prevent errors, providing at the same time the user with the appropriate on-line explanatory information, in order to complete a task effectively, efficiently and correctly.

These functionality issues have been taken into have been incorporated in the design of the prototype system.

**Usability Issues**

Usability issues can have a great effect in the success of an application. Thus, special consideration should be taken concerning usability issues in project management applications, since project managers and members have many responsibilities to concurrently take care of. A project management tool is required to be designed in a way that can minimize the time required in order to perform an operation. It is, thus, clear that manager actions must be short and receive immediate feedback. To accomplish this requirement it is important to minimize the occasions that users need to fill in data or perform several actions in order to complete a task.

Another usability issue that should be taken into account in a project administration system is to provide managers with the appropriate functionality in terms of tools that will assist them to complete their tasks. In many existing systems, managers should first create a project, then find it from the available project list and finally open it and decompose it into subtasks. Subsequently, the tasks should be identified and assigned to the appropriate members. A more usable approach could be to provide users with the ability to create a project then decompose it into various tasks and assign them to other users in a single step. Furthermore, managers should be able to pause in any of these steps if they do not wish to carry out all the steps at once. At a convenient time, the project manager should be able to resume the process and complete the task decomposition and assignment. Thus, mechanisms for locating recently created projects
should be available, presenting not only the newly created project but also the relevant
details, e.g., tasks and subtasks or assigned and unassigned tasks.

Another issue related to flexibility of management is the possibility of decomposing a
project in subtasks of arbitrary level. The usability issues identified concerning the
existence of arbitrary levels are related to the user’s confusion when dealing with many
levels of projects and tasks, and the lost in space syndrome likely to occur due to the
adopted navigation metaphor. The solution to the above issue is the adoption of a
hierarchical presentation of the task levels, such as a tree view representation.

Many applications implement the same interface and functionality for a software
development or a construction project. This might be confusing at first because it is quite
clear that a construction and a software development project are different kind of
projects, requiring different interfaces. The answer to that problem can be provided by a
structural analysis of these two kinds of projects. Firstly, both can be subdivided into
tasks. Each of these tasks can be further specified through defining task details.
Furthermore, users can be assigned with the responsibility to complete these tasks in a
predefined time period. Users also provide information about the progress achieved in
each task by filling in time reports describing the work done and the achieved progress.
Continuing the analysis, in both cases users can organize meetings related to the project.
Managers irrespectively of the project type need to have access to information, provided
by Gantt charts, status reports and project statistics. The above analysis provided
evidence that although the existence of different interfaces may seem more appropriate at
a first sight, a generic interface can effectively be applied to all different project types,
since in any project type the basic members’ tasks and needs remain the same.

Another usability issue that must be taken into account is that a graphical user interface
must be equally understandable by both experienced and novice users. However,
sometimes project management systems need to use complex terminology and/or
abbreviations that are not familiar to novice users. The solution to this problem is to use
terminology or abbreviations that are easy to understand for all the end users
irrespectively of their expertise in the scientific field of the project management
application, and to include the explanations or the full description of the abbreviations
used in the application. Thus, novice users could use this index to search for the
explanation of the unknown terms.

2.4 The WebPro system

To cater for the aforementioned functionality and usability issues, a novel project
administration system is proposed called WebPro. WebPro is a web-based system that
provides team members across an organization with a comprehensive and easy-to-use
environment for managing large and complex projects. This system addresses to project
teams that consist of members who are travelling, are located in different cities or
countries, and people outside the company, such as consultants or contractors, providing
the optimum solution as a project administration tool enabling at the same time effective
and efficient communication. The only necessary equipment that a project team member
needs to operate is a personal computer or a laptop or a handheld device with an internet
browser and access to the internet. In general, WebPro allows project members to collaborate and share information through a common channel anytime and anywhere.

WebPro supports and facilitates communication, cooperation and co-ordination of activities among company employees, customers and sub vendors, in all stages of a project. Furthermore, it enables the project team to access the most up-to-date project-related documents from any location and at any time, without the need to maintain massive paper files. Another benefit is that it helps to avoid problems, e.g., it is not possible for a part of the team to work with incorrect designs, since there is always the correct version on-line. The system, furthermore, offers a cooperative editing mechanism for project documents, based on an iterative review process, which allows original and reviewed versions of a document to be available for the users. This feature is very important especially when the organization has multiple distant workplaces.

In addition, WebPro enables project managers, through role based access rights, to control the data and functions that will be available to project participants. Other benefits of WebPro stem from the deliverable review mechanism. The basic issue that is addressed by such a mechanism is the need for cooperation between project members in order to create a project deliverable. This procedure entails in real life several reviewing iterations. In WebPro, when an electronic deliverable is created, the responsible project members are notified immediately to proceed with its review. When their review has been delivered, the responsible member is immediately notified. This mechanism provides the means to accomplish the required iterations in order to produce a deliverable of good quality.

Another aspect that is considered to be quite important in WebPro is the real time notification system. As it has been already mentioned, WebPro users can be located in different geographical regions, so an appropriate mechanism should be provided to these users in order to be immediately notified about issues concerning their work. This task is accomplished by the notification mechanism. Furthermore, users can be notified about several other issues related to their participation in a project, such as invitation to participate in a project or meeting, etc. In case of new assignments, relevant notifications are sent to the responsible member. In this way, the required communication between project members concerning everyday activity is automatically achieved.

The communication facilities provided by WebPro also include user-driven interpersonal communication tools such as message board and chat. The message board module provides asynchronous communication, and the users can post messages regarding any issue and view the replies that may be posted at any later time. The chat facility, on the other hand, provides the means of real time (synchronous) communication where users can participate in an online discussion and post or reply to any message posted by another user.

Another benefit from using WebPro is that it enables the project manager to decompose project workload in multi-level hierarchical tasks. The manager can create tasks that can be split to several sub tasks in order to be assigned to different members of the project team. This hierarchical structure allows full control and monitoring of the project work as well as rescheduling or reorganization of the project. Furthermore, the project manager is offered multiple views of Gantt charts, time-reports and project calendar which are
particularly useful in order to have an overview of the project. Gantt charts provide a graphical representation the project and tasks status. In this way managers can release resources for a task that is in front of its timetable and apply these resources to tasks that seem to delay project’s completion. On the other hand, time reports are useful for monitoring the amount of time employee’s work and for calculating salaries. Last but not least, project calendar contains information about appointments, meetings and deadlines of a project. The information provided by WebPro is very useful for managers and users in order to monitor and organize their activities.

WebPro offers also a user interface customization mechanism that can be used to adjust the user interface according to users’ individual preferences. When users select the configuration facility, several options are provided for modifying the system structure through adding or removing the available options according to the tools that are frequently used. If a message board facility is not used, for example, it can be removed through the configuration menu. Moreover, the users can customize the presentation of the content on the screen, altering the position of the display or the colours of the user interface.

Last but not least, WebPro was designed and implemented following a process where users, designers and usability experts had an important role. During the design and implementation of the prototype, several design iterations were made in order to encapsulate the results of formative evaluations. During these sessions, designers and end users were asked to review an early prototype of the system in order to recognize potential problems or issues such as lack of functionality, usability problems, difficulties in understanding terminology etc. The results of such a process offered to the developers the opportunity to adapt the systems design in order to fulfil user expectations and needs.

After the completion of the development phase, a final evaluation iteration was performed. The process adopted heuristic and user based methods which are two of the most popular evaluation approaches. Usability experts are involved in heuristic evaluation in order to identify existing usability problems and the consequences of these. The results provide feedback to designers and developers concerning the potential usability problems that they should solve before the system becomes available to end users. User based evaluation is carried out with the participation of target end users. They are asked to perform specific scenarios of use in a controlled environment and subsequently fill in questionnaires about the scenarios they have carried out, providing at the same time their overall opinion regarding the usability of the system. During this session, user actions are captured by cameras in the controlled environment of the usability evaluation laboratory, and the data collected through the cameras and the evaluation questionnaires are processed in order to identify possible interaction or usability problems. This process is very useful in order to ensure system success according to user needs and satisfaction.
3 System design and implementation

This chapter provides an overview of the design life cycle of WebPro in terms of user interface and database functionality. The first step of the design phase was the requirements analysis, followed by the tasks analysis. The design phase was completed with the creation of sketches of the user interface of the prototype.

3.1 Requirements analysis

3.1.1 Requirements engineering – The usability requirements model

Requirements engineering has been defined as “the activities involved in discovering, documenting and maintaining a set of requirements for a computer-based system” [8]. The overall objective of requirements analysis is to increase the effectiveness of software development projects, and therefore it must be accomplished during the first stages of software design. Requirements analysis focuses on the management of functional requirements, that state what a system would be able to do, while all other requirements are categorized as non-functional requirements. Non-functional requirements are usually seen as limitations in the design space for the design of functional requirements [9].

During the requirements analysis phase of WebPro, the model proposed in [9] and [10] was used (see Figure 3-1).

![Figure 3-1: Usability requirement model (adapted from [9])](image-url)
The above model is divided into five levels. At the first level, called “Analysis of context”, the work domain is analyzed and documented in relation to four areas, and namely tasks, users, environment and organizational goals. At the next level, called “System goals”, the system features are defined in terms of what the system should accomplish, what problems it should solve and what tasks it should support. At the third level, called “System requirements”, functional and interaction requirements are specified. Functional requirements can be specified as software requirements which are the programming requirements to provide features, and hardware requirements to execute the functionality. Interaction requirements concern communication between the user and the system. Functional requirements aim to attain usefulness and interaction requirements aim to attain usability. At the fourth level, called “Interface requirements”, the representational design of the graphical user interface is defined. In this step, both the visualization of information in the system and the visualization of the graphical user interface are specified. At the last step, called “Technical requirements”, all requirements are transformed to implementation requirements. Implementation requirements are requirements that can be directly implemented [9].

In the following subsection, the requirements analysis results for WebPro will be described.

### 3.1.2 Analysis of the context

At the level of the context analysis, the main task, the environment, the organizational goals of the system and the system users were identified. The main task of the system is to provide all team members across an organization with a comprehensive and easy-to-use environment (organizational goal) for managing large and complex projects. Additionally, the system would be used by team members who are travelling, are located in different cities or countries, and people outside the company (environment of use). The users of the system would be team members, and possible have different roles in the team. Three groups were identified, and namely the user group of managers, of moderators and of simple users. Project managers have the responsibility to organize and administrate a project. Moderators are a group of users that can have the same responsibility but in the context of a task and are directed by a manager. The simple users are those who work in the project and carry out the tasks that are assigned to them. It should be mentioned that the system should be accessible by users with different characteristics, including people with disability.

### 3.1.3 System goals

At this level of the requirements analysis, the system goals must be defined. WebPro is a project administrating system, and therefore it needs to include tools for organizing and administering projects.

To facilitate the organization and the administration of a project, the system should provide project managers’ with a variety of tools for decomposing a project to tasks and assigning them to project members. It is also important to provide various pieces of information related to other project members, such as skills or workload, in order to facilitate their assignment in project tasks.
Project managers should have the ability to supervise the project team and the work through the system. Therefore, the appropriate tools for monitoring each project member’s work and workload should be available, as well as meaningful graphical representation reports regarding project and task progress. Furthermore, the team members should have the appropriate tools to communicate with each other in order to exchange expertise, take decisions, ask or answer queries, discuss project or task problems and deliver outcomes.

Supporting the above facilities, WebPro provides users with the appropriate mechanisms to perform project administration activities with minimum complexity and maximum efficiency.

### 3.1.4 System requirements

At the level of “System requirements” the software, the hardware and the interaction requirements need to be specified. Software requirements describe the software features that must be incorporated into WebPro in order to help the users to achieve their goals, while hardware requirements concern the appropriate infrastructure for the system and the interaction requirements to encapsulate the necessary features that should be included in order to ensure quality of interaction between the system and the users.

The main requirement of project managers is to organize and monitor projects via the system. Project organization includes a number of functions that should be used in order to perform different operations. First of all, the project creation phase must be considered, where the manager should fill in the required information, such as project start date, due date, description, budget, etc. Subsequently, the manager should have the ability to decompose the project into tasks/subtasks and assign each task to project members. At the same time, the manager should be able to stop the project creation phase without completing, e.g., the task decomposition or the task assignment phase, and resume this process at a more convenient time. During the task decomposition phase, the manager should be able to define a new task, providing information about the task characteristics, such as title, description, start date, completion date, etc. There should also be the possibility to further decompose a task in subtasks and so on to the appropriate level according to the project needs. After the completion of the decomposition phase, the project manager should be able to assign the predefined tasks to the system users. The task assignment procedure is easily achieved by selecting the task and the user who will take the responsibility to carry out the task. This process should be facilitated by the system providing details regarding candidate’s workload and skills.

Other mechanisms that should be provided are related to the supervision and monitoring of the project. Thus, there is a need for a general status task overview, graphical representation of various metrics, e.g., Gantt charts to view task progress so that tasks that could delay project completion can be identified early. Moreover, since delayed tasks in a critical project path can delay the whole project, a relevant mechanism should exist, such as structure network charts, in order to assist identifying such cases as early as possible. Other project statistics should provide information about the project’s status, number of tasks, hours of work, estimated hours need, etc.
Another important feature is the time report mechanism, which allows managers to create reports about the hours worked by a specific user in a specific period. This mechanism can be proved very useful for monitoring progress and tracking project budget.

To achieve interpersonal communication among WebPro users, the need of formal and informal communication facilities is required. Formal communication is needed to deliver job results, to notify users about changes that affect their work and to exchange project documents. This is achieved with the use of a documents area facility and a notification service. Through the documents area, users can access and store project documents and reference material. The notification service offers automatic asynchronous and synchronous alerts via e-mail or SMS (Short Message Service) or via the integrated WebPro facility. The notification service should be able to send alerts when a task assignment or an event, meeting, or appointment invitation occurs. Alerts can also be sent when users report that a task has been completed or when a manager wishes to remove a member from its project team. On the other hand, informal communication is needed when a user wishes to exchange opinions with other users in an informal fashion. This should be facilitated by a message board component that will enable users to create threads representing topics for discussion. In addition, informal communication can be supported through a chat component that will provide users with the ability to create chat rooms of special interest to instantly discuss relevant topics with other users.

In order to provide high quality interaction, with the WebPro system should adopt human-computer interaction guidelines and especially WCAG 1.0 Level A guidelines in order to be accessible by all users, including users with disability.

### 3.1.5 Interface requirements

Interface requirements are particularly useful in order to achieve high quality of interaction. The user interface and functionality offered by WebPro have been designed and evaluated with the use of various human-computer interaction methods which are presented, with details and examples, in Section 3.3.

### 3.1.6 Technical requirements

The technical requirements are presented in details in Chapter 4.

### 3.2 Task analysis

The second phase of the WebPro design cycle was task analysis. User tasks are of special interest to developers, because “computer systems are designed to help people to carry out tasks more efficiently and to carry out tasks that were previously not possible” [11]. In general, task analysis provides a common ground between designers and users and “it allows designers to understand users’ work and users to understand designs” [12]. Task analysis is the process of analyzing the way people perform their jobs, the things they do, the things they act on and things they need to know [13]. The output of task analysis is the decomposition of the tasks that the users of the system usually perform and, depending on the techniques used, the plans and sequences of actions they use to perform their tasks.
Task analysis was used not to capture a form of requirements, but to contribute towards the complete statement of the requirements. The task structure stemmed from this method leded towards the creation of an internal model of the system which matched the expectations elicited from the users.

The hierarchical task analysis (HTA) method was adopted. HTA identifies a goal to be achieved by the user and describes it in terms of the task and plans required to achieve it. It involves iterative decomposition of tasks into smaller subtasks. In HTA, each task is continually broken down until an appropriate ending point is reached [13].

HTA is usually utilized to analyze tasks where a clear goal can be determined and tasks and subtasks are required to accomplish such a goal. The indication of variable steps and sequences is an essential part of task modelling, since there is always a degree of variation in the way tasks are performed. HTA is usually utilized for analyzing relatively simple cognitive and physical tasks [13].

The advantage of decomposing a task into subtasks (parts) is that “understanding the parts and their structural relationship can be instrumental in designing performable and learnable tasks, artefacts to facilitate these tasks, prerequisite instruction etc” [11]. Subtasks can be further expanded to capture more details. In some circumstances, subtasks can be broken down into individual keystrokes or mouse clicks. A detailed model of this kind would enable precise performance analysis. Furthermore, it is a very economical method, but nevertheless requires specific expertise on the part of the designer [14].

At first, a general analysis of the system structure was developed containing the basic ontologies of the system as produced by the requirements analysis in the “System requirements” step. This analysis is presented in Figure 3-2.

![Figure 3-2: General ontologies task analysis](image)

Subsequently, a more detailed analysis of the specific parts and actions was performed. Figure 3-3 presents an example of the actions required on behalf of the project manager to create a project and to assign tasks to users. Different task analysis schemas were created for different user roles, according to the access rights of each role.
3.3 Prototyping

After completing the task analysis phase, the prototyping phase was initiated. “A prototype is an easily changeable draft or simulation of at least a part of an interface” [16]. Several tools for prototyping are presented in Figure 3-4.

![Figure 3-3: Task decomposition of the “create project” task](image)

![Figure 3-4: Prototyping methods and tools [17]](image)

In the WebPro prototyping phase, a tool was used that belongs to the facade tools and have intermediate fidelity. Facade tools allow the creator to specify input behaviour next to the drawings and text, something which is not possible with pencil and paper. These
prototypes, which look and feel like the actual application, operate on a limited set of artificial data but nonetheless effectively show to users the impact of their actions [17]. Explanatory prototypes are drawings of prospective layouts of the system. They are usually very detailed - concerning typography, colour schemes, navigation and graphic elements. The tool that was used in order to produce prototypes was Microsoft PowerPoint. PowerPoint was chosen because is widely known, and users are familiar with it, while changes can be done quickly with higher precision than if drawn by hand. PowerPoint fulfils the requirements for good prototyping postulated by Szekely, 1994: “Ease of use, Fast turn around, Flexibility, Useful throughout the development cycle, Executable and Version control” [18]. The outcome of this phase, the prototype, allows designers and developers to work through the details of the system without doing extensive, time consuming, and expensive design and programming. Prototyping, in general, assists users to examine and alter things while the design is still flexible, before the final system is implemented.

In the WebPro design phase, a design prototype was elaborated to depict the functionality of the final system. In the remaining of this section, some representative screens are presented indicating the main characteristics of the system. The first example in Figure 3-5 represents the template of the general user interface that includes placeholders for the other components that will be used in the system. It consists of three navigation areas, the left navigation area that includes all the main functions that should be available to the users irrespectively of the task they perform, the central navigation area is the actual work place where the appropriate user interface component is loaded with the respective functionality for accomplishing the selected task and the right navigation area where the available choices of the selected task are presented. For example, when a user manages a project on the task level, in the option navigation area the task related functions are displayed such as add, edit, delete and assign task.

The second example in Figure 3-6 presents the four steps that a project manager has to follow in order to fill in the project details, to invite people to participate in the new project and to add and assign a task to one or more users.

The third example in Figure 3-7 represents the user interface of the statistical diagrams created by the system. On the options region, all the statistics diagrams available to a project manager are displayed.

An evaluation process of the prototypes was performed with the participation of user interface experts and end users. During evaluation, experts and users evaluators identified some problems that gave input to design iterations. An example of usability problem identified during the evaluation of the prototype was the existence of a options bar under the menu navigation bar, that confused users because the options bar position reduced the visibility of the navigation options of the menu bar. Thus, the options bar was repositioned in a separate area of the prototype and was clearly distinguished from the menu bar.
1. Main Page

![Prototype of the main page](image)

**Figure 3-5: Prototype of the main page**

---

### 4.3 Create Project Step 1

![Step 1: Create Project](image)

**Step 1: Create Project**

- **Project Name:**
- **Start Date:**
- **Due Date:**
- **Description:**
- **Objectives:**
- **Expected Results:**
- **Stage Limitations:**

---

### 4.4 Create Project Step 4

![Step 4: Assign Task](image)

**Step 4: Assign Task**

- **Task Name:**
- **Task Due:**
- **Priority:**
- **Estimated Hours:**
- **Description:**

---

### 4.2 Create Project Step 2

![Step 2: Add Member](image)

**Step 2: Add Member**

- **User Name:** John Smith
- **Email:** jsmith@sample.com
- **Role:**
- **Permission:**

---

### 4.5 Create Project Step 3

![Step 3: Create Task](image)

**Step 3: Create Task**

- **Task Name:**
- **Task Due:**
- **Priority:**
- **Estimated Hours:**
- **Description:**

---

**Figure 3-6: Prototype depicting steps of project creation**
8.7 Statistics – Deadline statistics

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Project Manager</th>
<th>Status</th>
<th>Start Date</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project 1</td>
<td>John Smith</td>
<td>30%</td>
<td>21/01/2004</td>
<td>21/01/2005</td>
</tr>
</tbody>
</table>

![Graph showing statistics](image)

Figure 3-7 Prototype depicting tasks statistics

3.4 WebPro ontologies

Before focusing on the implementation of WebPro, a brief description of the database ontologies will be presented. These ontologies correspond one to one with the ontologies described at the beginning of the task analysis section. The WebPro database ontologies do not provide an exact representation of the way ontologies are represented in the database, but a simplified abstract form in which unnecessary information is removed in order to provide a more understandable and intuitive representation.

Figure 3-8 represents the main WebPro ontologies that are used to store the main object types into database. Each of these ontologies is represented in a table containing either multilingual or monolingual information, and all the tables are interconnected according to the relationship between ontologies. For example, the connection between the project and member tables shows that each project has a number of participating members. Furthermore, the connections between task and project display that each project is decomposed into a number of tasks. Additional connections exist between project member-journal and journal-task that show that each project member fills a journal for a specific task.
Apart from the main ontologies, there are some additional ontologies used to describe structures and objects for several functions or components of the WebPro system. The most important of them are presented in Figure 3-9 and Figure 3-10. Figure 3-9 displays the notification ontology containing multilingual and monolingual information for any kind of notification. Each table contains information according to a certain type of notification, e.g., the project notification table contains information related to a project. Figure 3-10 displays the ontologies used in the document area and message board components respectively. These two tables are used to display either the folders or the documents inside a documents area. The connection between the documents and folders depicts that each document is stored in a specific folder. The Message board component consists of two tables that include topics and messages. The connection between messages and topics shows the relation between a message and a specific topic.
Figure 3-9: Notification ontology

Figure 3-10: Document area and message board ontologies
3.5 General architecture of the system

The outcomes of the system design phase were used as an input to the implementation phase of WebPro. Task analysis and user interface prototyping provided WebPro developers with a complete representation of the system. The next step was to transform the designers’ view of the final product into a real working prototype.

The WebPro implementation is based on a three-tier architecture that is presented in Figure 3-11. The three layers represent the data access layer, the business logic layer and the presentation layer.

The data access layer is responsible for storing and communicating data between the database and the application. This layer uses stored procedures for faster retrieval or insertion in the database, reducing the amount of client side processing by looking up data and maintaining key values and internal integrity. Furthermore, using stored procedures, the database server creates for each query a plan that includes all the information required to return the data effectively to the client. This plan is stored in the system’s cache, so that it can be reused when needed [19]. Another advantage of the stored procedure is that the database server can create indexes, thus increasing the speed of interaction.

The business logic layer contains web-services and data transformation functionality providing information to the presentation layer in a meaningful form. Web-services are implemented in the C# programming language using XML description files for communicating with the stored procedures. Thus, the business logic layer is totally independent from the implementation of specific parts of the data access layer, and allows the replacement of the data access layer without redeveloping the business layer. For example, the SQL Server database can be replaced by an Oracle database making the appropriate changes only in the XML description files. Another important feature implemented in the business logic layer is the data transformation functionality. This feature is used in order to transform data returned by web services into object types that can be easily manipulated at the presentation level. In order to achieve the transformation, a class was developed to capture the data returned by the web services and subsequently transform the XML data into programming language’s objects that can further be elaborated. The main benefit of this procedure is that it provides the ability to rapidly implement the presentation layer of an application without conveying complex structures. The same layer offers the mechanisms to perform all the necessary calculations, and the final data to be displayed are conveyed to the presentation layer.

The presentation layer is responsible for the user interface of the system and incorporates the designs created during the design phase. For the implementation of the presentation layer ASP.NET and C#.NET were used.
3.6 Technical characteristics

This section provides an overview of the WebPro implementation details as well as client software requirements. Implementation details concern the tools, programming languages, database management systems and query languages adopted to develop the functionality provided by each layer of the system. Client software requirements are the requirements that a client computer must meet in order to operate WebPro via the World Wide Web.

- **Implementation Details**
  - Microsoft .Net platform
    - Presentation layer
      - Single page Architecture
      - ASP.NET server controls
      - C# for the code behind page
    - Business logic layer
      - C# classes for data representation
      - C# Data access methods
    - Web services
      - C# web methods
      - XML unified data access wrappers
  - Microsoft SQL Server 2000 Database
    - Data access layer
      - Stored Procedures
      - Multilingual table architecture
Client – Requirements

- Internet Explorer 5.5 or greater
- Mozilla 1.x or greater
- Galeon
- Mozilla Firebird
- Konqueror 3.1 or greater
- Netscape Navigator 4 or greater
4 The WebPro System

In the previous sections, an overview of all the design and implementation details concerning the development of WebPro was provided. Chapter 5 provides a detailed description of “WebPro” functionality including aspects of the design rationale and system characteristics.

4.1 WebPro features

4.1.1 User roles and access rights

In the requirements analysis phase, three user categories were identified. Each of these categories uses the system performing different operations. For example, manager’s administrating tasks involve the project decomposition, task assignment, members administration etc. On the other hand, simple users fill in journals, communicate with other team members, etc. A flexible role based access mechanism was adopted in order to address these issues.

The identified user roles are manager, moderator and simple user. Users can have different roles depending on the task of the project they work for, as depicted in Figure 4-1. In this figure, User1 is moderator for Task1 and Task2 of Project1, and 2 simple user for Task1 of Project2.

![Figure 4-1: First example of access rights hierarchy](image)

The access rights of the users depend on the roles that are assigned to them. There are three kinds of access right levels according to the user roles identified in WebPro.
• **Managers Access Rights.** Managers have full access rights to all project functions, subprojects and tasks controlling everything that is related to the project workflow.

• **Moderators Access Rights.** Moderators have increased responsibilities concerning the subproject or task they administer, e.g., to ensure quality and timely delivery of work.

• **Simple users.** Users are the ones who carry out the tasks and produce the final deliverables of the project.

Thus, users should have different access rights depending on the project that they participate; a user can have manager access rights to a project and user access rights to another project. Moreover, if a project is decomposed into various tasks and subtasks, it is possible for a user to have different access rights for two tasks of the same project, as depicted in Figure 4-2., where user1 has moderator access rights for task1 and user access rights for task3.

![Figure 4-2: Second example of access rights hierarchy](image)

### 4.1.2 Members administration

One of the major responsibilities of a project manager is to select the team members that will participate in a project. As previously discussed, this is a very important task, since an experienced team can work effectively and efficiently, thus reducing the risk of delay or failure. Therefore, project managers should select the best team to work on a project. The required skills are not only technical skills, but also problem solving and interpersonal skills. In general, good team members gain high self-esteem and show strong commitment to the project’s success [2].

In order to facilitate such task, WebPro includes a user profiling mechanism. During the registration process, users have to fill in a form concerning their expertise and their qualifications. The provided information can be used when a manager selects members
for the project team. Moreover, the manager is provided with a member administration facility that provides the opportunity to invite a new user to participate in the project or remove an existing user from a project. Furthermore, managers can view the workload of each member, which is a metric that indicates the time that a user can allocate to a new project. The workload computed by the system based on the number of tasks in which a user is engaged during a specific time period. In this way, managers have the ability to make the best decisions in terms of availability and experience of the user they wish to invite.

4.1.3 Projects – Tasks

The following subsections present the available mechanisms for creating, describing and organizing a project.

4.1.3.1 Project General Characteristics

In WebPro, users with the role of manager can create new projects by selecting the appropriate function. During this phase, they must fill in a form with the basic project details such as title, description, estimated hours, and completion date.

4.1.3.2 Project Plan

During the creation of a project, the manager has to fill in some information related to the project in order to formulate the project plan. The project plan is a set of statements that describe the overall approach of project development, specify the resource requirements, project budget and organizational responsibilities, and define the management processes. In addition, the project plan outlines all risk factors and risk management strategies, as well as how changes are managed and the quality of the deliverables is assured. The information provided by the project manager is used to inform team members.

4.1.3.3 Project decomposition

Project decomposition enables the project manager to decompose the project into hierarchically structured, well-defined and manageable tasks or activities. In Figure 4-3 the theoretical model of project decomposition is illustrated. The number of decomposition levels is related to the work of the project and the work model of the project manager. It is also important in this process to identify the tasks that should be completed in order to consider the whole project as completed.

WebPro supports project decomposition allowing the project manager to create several multi-nested hierarchical tasks with an unlimited number of subtasks. Moreover, apart from project managers, moderators can split a task to several other tasks according to the workload, estimating the required hours to complete the subtasks. Moderators can also assign the new subtasks to other users and distribute the workload according to the availability of the users. In that way, a complex task is managed more efficiently and effectively, since it is split into subtasks assigned to several users. Simple users cannot break their tasks into subtasks; they can only work to complete the assigned task. Figure 4-4 and Figure 4-5 present the project’s list and the task decomposition of a project in WebPro.
Figure 4-3: Project decomposition

1. Project Decomposition Phase

2. First level tasks decomposed into second level tasks

Figure 4-4: WebPro Project list screenshot
4.1.3.4 Task Assignment

Task assignment can take place when a project manager or moderator decomposes a project to tasks or a task into subtasks, or when it is necessary to distribute unassigned tasks. The user who will take the responsibility for completing a task is selected among all the users of the system. The project manager or a moderator can invite any user to participate in the project having reviewed the user’s workload and profile from the appropriate option.

The progress of each task is represented by a percentage value that depicts the amount of work done. In the case of one level tasks this percentage is calculated based on the work done by each user of that task and the estimated hours needed. On the contrary, when tasks have more than one level, the percentage value is calculated based on the average progress status of each subtask.

4.1.3.5 Team organization and responsibilities assignment

Team organization as well as the assignment of the responsibilities inside a team, is a key factor to the project success. The way that teams are organized has an enormous effect on how efficiently they perform. An inappropriate team structure can lead to longer development time, can raise the cost of the project, can provide results of poor quality, and can lead to poor communications and morale. In order to help project manager to organize an effective and productive team WebPro offers a dynamic project decomposition mechanism, through which managers can create flexible project structures that can adapt to each project demands.
This mechanism takes advantage of several features provided by WebPro. The task project hierarchy and the task decomposition function are used in order to break tasks into subtasks and create levels of tasks. Furthermore, the access rights system can be used by the managers to assign different roles to different users for different tasks. With the help of the above features, a large variety of team structures can be created.

There are a number of very popular team structures that are widely used in modern organization, and are supported in WebPro:

1. Direct Assignment: The project manager decomposes a project into several tasks and then selects the assistants that will take the responsibility for completing each task (see Figure 4-6).

2. Multiple Assignments: The project manager decomposes a project into tasks and selects the assistants for each task. In many cases, it is necessary for a project member to apply his or her expertise across many tasks of a project. The primary advantage of this structure is that it allows special expertise to be used most effectively (see Figure 4-7).

3. Indirect Assignment: The project manager decomposes a project into a number of tasks and decides to assign a large task to a chief organizer (moderator). This user can in turn decompose this task into several subtasks and then select the assistants needed in order to complete each task (see in Figure 4-8).

Figure 4-6: Direct assignment team structure
Figure 4-7: **Multiple Assignment team structure**
As shown in the previous examples, the project-task decomposition mechanism in combination with the flexible access rights approach provide the means to effectively represent almost any kind of team organization scheme. Therefore, it is not required for a project team to alter its structure in order to take advantage of the project administration capabilities of WebPro.
4.1.4 Administration Tools

It is essential for the success of a project to provide managers with the required tools for their job. WebPro administration tools provide the means for controlling and monitoring their project and human resources. The existence of these tools is very important because the job of managing projects is very demanding. Few people have the qualifications and the necessary attitude to succeed in managing complex projects. Having a certain level of technical competence is helpful, but managerial and interpersonal skills are the most important for project managers. WebPro administration tools are designed to help managers with the required qualifications to perform their tasks in a more effective way.

4.1.4.1 Statistics

Statistics data can help project managers to maintain a general overview of the entire project and to effectively control their working team. WebPro has a wide variety of graphical and non-graphical statistics tools that provide the required information even for the most demanding managers. Statistics are not equally accessible by all users. Generally, project managers have access to any statistics concerning the projects they administer. On the other hand, moderators have the same privileges as managers but in the context of the task they moderate. Finally, simple users have access to statistics related to the tasks they participate. WebPro provides three main categories of statistical information, namely general, member and task statistics.

General statistics provide managers with information about the total number of tasks, the status of the project, the number of completed tasks, the number of members participating, and finally the estimated time required for project completion. On the other hand, moderators can view the same information about the tasks they moderate and simple users are not allowed to view this category of statistics.

Member statistics provide managers with information about the average or the total working hours for any member in any time period of the project’s lifecycle. This information is presented in the form of graphs where each bar represents the selected users. This category of statistics is also available to moderators and simple users. Moderators can have access to this information for the users participating in their tasks and simple users on the other hand have access to their personal statistics.

Finally, task statistics can provide information about the amount of hours spent per task and per member or task status which enables managers to compare several tasks in terms of their status. Last but not least, deadline statistics can provide information about the progress of the entire project providing a pie chart with the percent of tasks that are completed on time, before deadlines and those that have exceeded their deadlines. Moderators can access the same information as managers but in the context of their tasks.

4.1.4.2 Gantt charts

The most common form of presenting schedule information is the Gantt chart, which represents activities against a horizontal time scale (see Figure 4-9). Gantt charts are popular because they are well understood and easy to create and revise. In WebPro, Gantt charts were adopted as a way to provide diagrams that can show the schedule for the tasks of a project. These charts show a list of tasks with bars that represent the time
duration of each task. To give more information to users, the progress of each task is incorporated in the task bar with colour coding for better representation. Furthermore, a different representation is provided for tasks with open or exceeded deadline. The information provided by these charts can be useful in order to identify the tasks that are in a more critical state and therefore require more effort in order to be completed in time.

Gantt charts are accessible by all users according to their access rights. Managers have access to charts for all the tasks of their project. Moderators on the other hand can view the charts for their tasks and subtasks they moderate while simple users can view charts for the tasks of the specific project that are assigned to them.

<table>
<thead>
<tr>
<th>Task Name</th>
<th>Assigned</th>
<th>Qtr 1</th>
<th>Qtr 2</th>
<th>Qtr 3</th>
<th>Qtr 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1</td>
<td>Partarakis, Nick</td>
<td>Jan - May</td>
<td>Jul</td>
<td>Oct</td>
<td>Nov - Dec</td>
</tr>
<tr>
<td>Task 2</td>
<td>Doulgeraki, Dina</td>
<td>Jun - Sep</td>
<td>Nov - Dec</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 3</td>
<td>Karampelas, Panagiotis</td>
<td>Feb - Apr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 4</td>
<td>Partarakis, Nick</td>
<td>Jun</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Gantt chart](image)

Figure 4-9: Gantt chart

### 4.1.4.3 Time report - Journal

All the users that participate in a project should fill in a daily form for each task that they work. Such a journal captures information regarding the hours worked for a specific task, allowing the automatic calculation of the task’s progress. Journals can also provide clues about the time that a specific user spent in order to accomplish a certain amount of work.

The Journal is also connected with the deliverable review process. Employees working in big organizations or research laboratories are familiar with the term deliverable as the outcome of their work. Through the journal mechanism, the users can announce that they have finished the assigned tasks, delivering the outcomes of their work to the manager or moderator by filling in the last journal of the respective task. The assigner of the task is automatically informed with the help of the notification mechanism about the completion statement and can review the delivered work if required.

The Journals also contain valuable information that can be used for the production of time reports. Time reports are forms that contain information concerning the total working hours spent by a user in order to complete the assigned tasks. Time reports are available to project managers who can view the time reports of all users participating in a
project and to moderators that can view the time reports concerning their tasks and subtasks. Simple users though can view only their personal time reports.

Finally, time reports can also be extremely useful in situations where employees are getting paid by the hour, as they can be used to calculate the salaries of the employees.

4.1.5 Communication

Communication is very important for the success of a project and team members should be able to communicate in various fashions. The term communication in WebPro is used to describe procedures that can be initiated by the user or by the system. User initiated communication occurs when a user wishes to transmit information to other project members while system initiated communication occurs automatically in order to notify users about issues that affect their work or responsibilities. For example, when a user is invited to participate in a project, the system will automatically send a notification.

The communication facilities offered by WebPro can be distinguished into formal and informal communication. Formal communication occurs when formal documents are transmitted or when automated notification are sent, e.g., for participation in a meeting, while informal communication concerns the informal exchange of thought or the quick discussion related to a specific issue through chat rooms or message boards.

4.1.5.1 Formal communication functionality

Many project failures are related to problems occurred because of the lack of appropriate communication between project participants. It is the responsibility of the project manager to create the grounds for effective communications within a team and to manage the communication process with external stakeholders, particularly with the client’s organization. In the following sections the tools provided by “WebPro” to facilitate easy and effective communication are presented.

4.1.5.2 Documents area

In many occasions, project members need to communicate in order to enhance a project document or deliverable. Therefore, the existence of a documents area is of great importance in order to provide users with the means to store and share project documents and files in general. These files can be reference material, results of an individual task, deliverables or any other kind of file that users wish to share with other project members. Furthermore, users should have the ability to create folders that are dedicated to a task or a project, secured by unauthorized access. In order to ensure the security of shared files, all users should have access rights that depend on their role in a specific task.

The WebPro documents area is designed to satisfy the above requirements. Users with the required access rights (managers and moderators) can create folders and dedicate these folders to a task or project. Additionally, these users can create folders that can be accessed by all WebPro users (Public folders). WebPro allows the creation of an arbitrary number of folders’ levels. The hierarchy of folders is represented through a tree view hierarchy in order to easily locate folders and documents. Users can upload documents to a folder if they have the required access rights. In general, users with manager access rights can upload files and documents to folders dedicated to the project they manage. On the other hand, moderators can upload files in folders dedicated to their task or subtasks,
while simple users can upload documents to folders that are related only to the task they participate. Users with manager and moderator access rights have also the ability to administer (rename, delete, move) folders and files through the built-in administration functionality, while simple users can only administer files that have been uploaded by them.

4.1.5.3 Project contacts

The communication process with external stakeholders, particularly with the client’s organization, is very essential. WebPro provides managers with tools to create a list of contacts for each project. Each contact is registered and maintained in the system along with information such as name, description, fax, phone and e-mails. Contact information is used when project managers wish to send reports about project status to the client organization. WebPro offers to managers an automatic report function that when activated automatically generates a report with various information about the project and is ready to be sent to the desired persons. This report contains details concerning project and tasks statuses, estimated hours, estimated completion date, etc. Managers have the possibility to send this report to the client organization in the form of e-mail. This is a very important mechanism because it automates the client interaction process and managers need only to specify the project contacts that will receive the report in order to complete this process.

4.1.5.4 Notifications

Users participating in a project team must be instantly notified about events that have a direct effect on their work. For example, all the users should be notified when they are invited to participate in a project. WebPro supports two different forms of notification, namely real time interactive notifications and asynchronous notifications.

4.1.5.4.1 Real time interactive notifications

One of the most powerful aspects of WebPro is its real time multi purpose notification facility. In order to understand the need of a real time notification facility, an indicative scenario of use is provided: the manager of a project using the calendar provided by WebPro creates a meeting entry and inserts the names of the project members that should attend this meeting. Without the notification facility the users would get informed about the meeting when they would look at their calendar or email inbox. WebPro automatically sends a notification to the selected users, and the notification is displayed instantly in their working area if they are online or when they login on to the system. The mechanism that displaying the new notifications is activated when the content of the main page of the web application is reloaded.

Real time notifications can also be browsed in two different ways. Firstly, in the user work space there is a window containing the latest notifications in the form of links. Each time a new notification arrives, a new link appears in that window, containing information about the title, type and sender of the notification message. Furthermore, there is a specialized notification component that contains the same message with more details. Through this component all the users can browse, delete and reply to notifications.
The real time notifications provided by WebPro can be classified in the following categories:

**General Notifications:** This category includes notifications such as invitations to participate in a project or notifications that a specific user is released from a project.

**Event / Meeting / Appointment notifications**, containing Event / Meeting / Appointment invitations which are sent when events have been created in the calendar component (Section 4.1.7.1). For example, when the users create a new meeting in the calendar they can define which project members should participate in this meeting. Each member is automatically notified about the upcoming meeting through this type of notifications. The user, upon receiving the notification, can revise the details in the work area and accept or deny the invitation by making the appropriate selection. The feedback notification is returned to the initial sender of the invitation. The second subcategory of this notification type is Event / Meeting / Appointment cancellations, which are notification about event cancellations. If for example, a manager decides to cancel an event, all the invited members are automatically notified.

**Task Assignment notifications** notify project members that a new task is assigned to them. The message contains information about the project, the manager and the task characteristics. Task assignments are interactive, since users can accept or deny the task by making the appropriate selection. The feedback from the user is sent again automatically to the project manager or the moderator who initiated the notification procedure.

**Task Completed notifications** initiate the review procedure. As a preliminary phase of the review procedure, the project manager creates a new task and assigns the review of this task to a group of reviewers. A task completed notification is created when the user responsible for that task reports in the journal that the task has been completed. A notification is then sent to the task’s reviewers, containing information about the task and the related deliverables. Reviewers can in return reply to that notification in order to accept or deny the review status of the task. A feedback notification is sent back to the responsible user including the results of the reviews.

4.1.5.4.2 Asynchronous Notifications

Asynchronous notifications are subdivided into email and SMS notifications. For example, when a new task is assigned to a user, an email can be automatically sent, containing information about the assigned task, the project and finally the manager of the specific project. Similarly, SMS notifications contain the same information.

### 4.1.6 Informal communication functionality

#### 4.1.6.1 Chat

All the communication facilities described above address the need for formal communication. However, the need for informal communication between project members is identified as equally important. Informal communication traditionally occurs on an occasional basis, and gives project manager the ability to discuss with the team members in order to obtain their feedback regarding the project progress. In a web-based
application such as WebPro, project members can be located in different countries or organizations so this kind of interpersonal communication is not always possible.

WebPro in order to address the need for informal communication provides a chat component (see Figure 4-10) where the users can create chat rooms and discuss any topic of interest. These rooms can be accessed by all users (public rooms) or by the participants to a specific project (project rooms). WebPro provides the appropriate mechanisms to restrict access to chat rooms according to user access rights.

![Figure 4-10: Chat component](image)

4.1.6.2 Message board

WebPro also provides a message board component in order to facilitate asynchronous communication among users. Users can create new topics that represent a conversation thread for a specific matter. Topics can be addressed to all system users (public topics) or to members of a specific project (project topics). For example, a public topic can be related to C# programming and a project topic can be related to the requirements analysis phase of a project. Project topics provide the ability to users responsible for different tasks to cooperate and help each other by sharing knowledge and experience. In the same way, public topics are used as means of general conversation and brainstorming between users working in different projects.
WebPro in order to provide confidentiality and security can restrict access to users according to their access rights. All the users can access only the topics that are related to the projects in which they participate.

4.1.7 Communication related facilities

In this section, an overview of two facilities that are related to communication is provided, namely the calendar component and the deliverables review mechanism.

4.1.7.1 Calendar

Usually project members and managers have many responsibilities such as participating in meetings and events organized for the project, etc. Under these circumstances it is important to provide users with appropriate means to organize and participate in such activities. The WebPro calendar is a very powerful component of the system, since it can provide information and notification about the registered events, meetings and appointments.

A user can register a meeting to the calendar by entering the appropriate information such as meeting location, date etc. The user can alter the information by using the build in administration features, and use a colour-coding scheme in order to make different kind of information more visible and easy to be located on the screen.

Furthermore, another important feature offered by the calendar component is the existence of three alternative display forms (daily, weekly or monthly calendar). Users can select the one that suits their needs at a particular point in time. Each of these forms has differences in the level of detail presented. In case the users select the monthly calendar, only the main characteristics of each record will appear on the screen, while in the weekly or daily calendar displays additional information will appear, such as the time and the location of an appointment etc. The administration facility of the calendar allows users to add, alter or delete records from the calendar.

Since many people participate in many projects, different events and meetings are organized in parallel. Thus, the calendar component can be configured to display the project or user related entries. Project calendar contains information about all events, meetings, appointments that are related to a specific project while the user calendar provides only the information related to an individual user, such as meetings, events and appointments in which the user participates.

4.1.7.2 Deliverables Review

Quality assurance (QA) in a project ensures that a product meets user requirements and provides the desired functionality and quality [2]. The main purpose of QA is to detect and correct errors as early as possible. Early detection and correction of errors can result in significant cost and schedule benefits. The cost of correcting errors in the design phase is about one tenth of the cost of correcting them in the testing phase. While the whole project team should be committed to building quality into the project, it is a general practice to have a separate individual or a group (reviewers) whose primary responsibility is quality assurance.
In order to incorporate QA in the WebPro system, the deliverable review mechanism is provided, which enables the manager or a moderator of a task to create a small group of reviewers for the specific task. The responsibility of this group is to evaluate the results of the task and decide whether these are satisfactory or should be revised. The evaluation procedure is initiated when a user reports by the journal that a task has finished and delivers the output of the tasks. In the journal form the user fills in a percent value that represents the status of the task. If this value indicates that the task is completed, then the deliverables of the task are sent to the reviewers that have been identified by the project manager or the task moderator. Then the reviewers decide whether the quality of the deliverable is acceptable or needs further elaboration. In the latter case, the task remains unfinished and the responsible user is notified that corrections should be made. This procedure can be iterated until all reviewers are completely satisfied about the results of the task.

4.1.8 Notepad

Developers and people that work in large organizations usually maintain log files where information, such as to-dos or notes, is stored. WebPro offers a mechanism called Notepad where users can store their personal notes or to-dos in a restricted area and have access at anytime. This component was incorporated in WebPro because one of the main goals was to provide users with the widest possible set of tools for effectively achieving their goals.
5 Usability Evaluation

The last phase of the WebPro development is the evaluation of the final prototype. For that purpose, two evaluation approaches were adopted: heuristic evaluation and user testing.

5.1 Heuristic evaluation

Heuristic evaluation - one of the most popular usability inspection methods - is a usability engineering method for identifying usability problems in a user interface design. Heuristic evaluation involves an inspection from a small group of expert evaluators who examine the interface and judge its compliance against recognized usability principles (the heuristics). In general, heuristic evaluation is difficult for a single individual to carry out, because one person will never be able to find all the usability problems in an interface. Experience has shown that different people find different usability problems. More specifically, it has been proved [20] that the sets of usability problems found by different evaluators are in large part non overlapping. Some usability problems are so easy to find that they can be detected by almost everybody, but there are also some problems that are found by very few and experienced evaluators. Furthermore, one cannot just identify the best evaluator and rely solely on that person's findings, since it is not necessary that the same person will be the best evaluator every time, while some serious usability problems are found by evaluators who may not find other common usability problems. Therefore, it is necessary to involve many evaluators in a heuristic evaluation in order to significantly improve the effectiveness of the method. The ideal number of evaluators that should be used in a heuristic evaluation has been calculated by Nielsen and Landauer [20], who presented a model based on the following prediction formula for the number of usability problems found in a heuristic evaluation:

$$\text{ProblemsFound}(i) = N \left(1 - (1-l)^i\right)$$

where ProblemsFound(i) indicates the number of different usability problems found by aggregating reports from i independent evaluators, N indicates the total number of usability problems in the interface, and l indicates the proportion of all usability problems found by a single evaluator.

This formula clearly shows that there is a good payoff from involving more than one evaluator. It is recommended to use three to five evaluators in the procedure, since fewer evaluators cannot detect an adequate number of problems, while using a larger number of evaluators does not provide additional information concerning the usability of the system. The evaluation will be performed by allowing each individual evaluator to inspect the interface alone. After the completion of all evaluation sessions, the evaluators will communicate and aggregate their findings. This procedure is important in order to ensure independent and unbiased evaluations from each evaluator. The results of the evaluation can be recorded either as written reports from each evaluator or by having the evaluators verbalize their comments to an observer as they go through the interface. During the evaluation session, the evaluator examines the interface several times, inspects the various dialogue elements and compares them with a list of recognized usability principles (the heuristics). These heuristics, which are presented below in more details,
are general rules that describe common properties of usable interfaces. In addition to the checklist of general heuristics, the evaluators can also consider any additional usability principles or results stemming from their expertise. Furthermore, it is possible to develop category-specific heuristics that apply to a specific class of products as a supplement to the general heuristics. The output of the heuristic evaluation method is a list of usability problems related to the system’s user interface, with references to those usability principles that were violated by the design according to the opinion of the evaluators. It is not sufficient for evaluators to simply say that they do not like something; they should explain why they do not like it with reference to the heuristics or to other usability principles.

Many advantages are claimed for heuristic evaluation. One of the most important is that the method provides quick and relatively inexpensive feedback to designers, while the results generate good ideas for improving the user interface. On the other hand, the development team will also receive a good estimate of how much the user interface can be improved.

Additionally, there is a general acceptance that the design feedback provided by the method is valid and useful. Heuristic evaluation can lead to many usability improvements to take place before a release deadline that would not permit an extensible usability testing involving end users. If the development team is open to new ideas, heuristic evaluation can be an excellent investment of usability resources. One of its great advantages is that it can be performed early on the design process since earlier discovery of usability problems during the development lifecycle helps in identifying and correcting obvious usability problems with very limited costs. Furthermore, carrying out a heuristic evaluation on early prototypes, before actual users are brought in to help with further testing, provides a focus for later usability testing and decreases users’ time and effort spent in the usability test.

**5.1.1 Rating usability problems**

Usability problems’ rating according to their importance is a fundamental phase of the heuristic evaluation procedure. As a result, redesign resources will be allocated so as to eliminate the most severe problems first. A problem’s severity may be described as a combination of three issues:

(i) the frequency of its appearance (i.e., frequent vs. rare), (ii) the impact of its occurrence (i.e., the difficulty encountered by the user in overcoming the problem), and (iii) its persistence (i.e., whether it is a problem that users may overcome if the run into it once, or if they will be repeatedly bothered by it).

In order to determine the severity of usability problems, the following scale is used:

0: It is not a usability problem.

1: It is an aesthetic problem only: unless there is available time, redesigning is not necessary.

2: It is a minor usability problem: eliminating such problems will be assigned a low priority.
3: It is a major usability problem: removing such problems will be given a high priority.
4: It is a usability catastrophe: such problems should be definitely eliminated.

5.1.2 Heuristic rules

The ten general heuristic rules that have been used for the evaluation of WebPro are the following [21]:

Visibility of system status
The system should always keep users informed about ongoing procedures, through appropriate feedback and within reasonable time from the relevant actions of the user.

Match between system and the real world
The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than using system-oriented terms.

User control and freedom
Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state, without having to go through an extended dialogue.

Consistency and standards
Users should not have to wonder whether different system messages, situations, or actions mean the same thing. Thus, their interpretation should be unique and intuitive for the users.

Error prevention
A careful design, which prevents a problem from occurring in the first place, is even better than helpful error messages.

Recognition rather than recall
Objects, actions and options should be visible. The user should not have to remember information from one part of the interface dialogue to another. Instructions for use should be visible as well, or easily retrievable when appropriate.

Flexibility and efficiency of use
The system should cater to both inexperienced and experienced users.

Aesthetic and minimalist design Information that is irrelevant or rarely needed should not be presented at first level.

Help users recognize, diagnose and recover from errors
Error messages should be expressed in plain language (no codes), precisely indicating the problem, and constructively suggesting a solution.

Help and documentation
Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to
search, focused on the user's task, list concrete steps to be carried out, and not be too large.

5.1.3 Results of WebPro heuristic evaluation

In this section the results of the heuristic evaluation are presented:

1) Project and tasks need reorganizing. The user had to select one project in order to view its tasks and one task to explore its subtasks. Normally, when the users need to navigate in a hierarchy of arbitrary depth, they will be eventually lost (the lost in space problem) if a clear navigation technique is not provided.

2) The same problem was identified in the documents area. In an n-folder hierarchy user will eventually be lost while browsing subfolders without the appropriate orientation information.

3) The journal and time report functions are presented as different components of the system. This is considered to be a usability problem since in the journal, users should import information that presented by time reports so there must be a connection between the two functions.

4) The manager of more than one projects do not have a general overview of all the projects progress together.

5) When a user selects more than fifteen members to view statistics the bars on the graph are very close and the graph is not usable.

6) The same problem was identified in task statistics.

In the figures below the general evaluation results are presented as graphs.

Figure 5-1 presents the problems identified in terms of their impact. The first two problems were identified as very difficult for users to overcome while third and fourth problems were described as easy for users to overcome. The impact of the final two problems was identified to be medium. In that way usability experts stated that users can overcome these problems without considerable effort.

![Impact](image-url)

Figure 5-1: Usability problems by impact
The persistency of the usability problems identified is presented in Figure 5-2. As shown in this chart the first and last problems are identified as particularly difficult for the users to overcome. On the other hand third and fourth problems are considered to be easier to be overcome.

![Persistency](image)

**Figure 5-2: Usability problems by persistency**

Figure 5-3 presents the problems identified in terms of their severity. The first two problems were considered by most evaluators to be major or catastrophic usability problems that must be given high priority in the redesign phases. The third problem was not identified as a usability problem in terms of severity. Finally, the three remaining problems were described as major usability problems that also must have high priority in the system redesign.

![Severity](image)

**Figure 5-3: Usability problems by severity**
5.1.4 Results of heuristic evaluation in terms of severity

The main purpose of the heuristic evaluation was to identify major usability problems. The results of this process were used as input for redesign iterations in order to improve the usability characteristics of the final product. Six problems were reported totally and will be presented in descending severity.

Figure 5-4 presents the usability problems identified in descending severity. The severity of each problem states the priority that must be assigned to each of them during the subsequent design iterations. The problems with higher severity must be eliminated before the ones with lower severity.

![Severity grades](image)

Figure 5-4: Usability problems by descending value of severity

5.2 User Testing

The purpose of this user-based evaluation was to determine whether the system was usable and more specifically to assess its usefulness, effectiveness, learnability and likeability. Usefulness concerns the degree to which a system enables users to achieve their goals. If a system is easy to use, easy to learn and satisfying, but does not achieve the specific goals of a specific user, it will not be used. Effectiveness (or else ease of use) is usually defined quantitatively, either by speed of performance or error rate. Learnability concerns the user's ability to operate the system on some defined level of competence after some predetermined amount and period of training. Finally, likeability refers to the user’s perceptions, feelings and opinions of the product, usually captured through both written and oral interrogation. Users are more likely to perform well on a product that meets their needs and provides satisfaction.

5.2.1 Evaluation laboratory

One of the most important considerations during an evaluation procedure is to prepare the environment in which the user testing will be performed, since the context of use can greatly affect a product’s usability [22]. In the case of WebPro, the test has been
performed in a usability laboratory. The main functionality of such a laboratory is to provide the evaluation coordinators with the possibility to systematically study the interaction between the user and the system under evaluation.

During the preparation of the evaluation laboratory, it should be kept in mind that the environment of use should be similar to the environment in which the system will actually be used. In the specific case, the evaluation target is the WebPro tool, which is a web site. Consequently, the expected environment of use is an office environment, and the tool is expected to be operated using a common web browser of a personal computer. For the evaluation testing a personal computer was used, running Windows 2000 and the browser that was employed was Internet Explorer 6.0.

The testing environment was the Usability Laboratory of ICS – FORTH, a classic usability testing laboratory, which consists of one room designated as the testing room and a second room designated as an observation and control room. The participant is in the testing room alone or with an observer, while all other personnel are in the control room, observing the participant through a one-way mirror. The communication between the participant and the control room is realized through a microphone speaker infrastructure, while user interaction with the software is recorded through two cameras. A more detailed image of the laboratory setting is presented in Figure 5-5:

![Figure 5-5: Evaluation laboratory of ICS - FORTH](image-url)
5.2.2 Selecting users

In order to make sure that the test results are be valid, the end users to be involved should be carefully selected in order to be representative end users of the system, or at least as close to that criterion as possible. Consequently, the selection of participants with the appropriate profile and abilities was a very crucial step during the test preparation. The most important guide towards this end was the description of the typical user’s profile that had been developed during the first design phases of the system.

During the preparatory phase, all the materials to be used during the test sessions were prepared, namely the orientation script, the tape consent form, the pre-test questionnaire, the interaction scenario and the post-test questionnaire. All the appropriate materials are presented to Appendixes.

5.2.3 Interaction scenarios

Nielsen [23] defines interaction scenarios as a description of a user who interacts with a system (or a set of systems) in order to accomplish a specific outcome in predefined conditions and within specific time duration.

More specifically, the scenarios that have been given to the participants contained five main tasks to be completed. These tasks are:

- Create a project with all the appropriate details, invite two members to participate, create a task of the project and leave it unassigned.
- Add a project event to the project calendar and then change the event date, duration and name.
- Find a specific task, read related information, move it to another task as subtask and assign it to yourself.
- Read your personal time-report for a specific period and fill in the daily journal for a specific task.
- Edit and upload a document. Then move a folder and a document to another folder.

5.2.4 Post-test questionnaire

The post-test questionnaire that was used is the “IBM Computer System Usability Satisfaction Questionnaire (CSUQ)”. CUSQ questionnaire consists of nineteen questions that present the user scale concerning system’s usability. The process of filling in the questionnaire last at least ten minutes and is performed after the completion of the interaction with the system. The study of the questionnaires offers semantic results about the usability of the system. Furthermore, with the average of the grades about specific questions categories are being calculated specific usability factors as:

Overall usability (OVERALL): the average of all the answers’ grades.
System use (SYSUSE): the average of the answers’ 1 to 8 grades.
Information quality (INFOQUAL): the average of the answers’ 9 to 15 grades.
Interface quality (INTERQUAL): the average of the answers’ 16 to 18 grades.
The post-test questionnaire that was used is presented in Appendix I.

5.2.5 Transforming data into findings and recommendations

After the preparation of the usability laboratory as well as the evaluation material, the test is performed and the relevant data are collected. The next step is to process all the data that were gathered and turn them into meaningful conclusions and useful suggestions for improvements. Towards this end, the collected information (both objective and subjective) should be analyzed and presented in various formats. Then the tasks that did not meet the criteria that were initially set, as well as the user errors and difficulties should be pointed out. Finally, problems should be prioritized by criticality in order to help the development team to decide set priorities concerning the changes that will be made for the final system version. The results of this analysis will be presented in the following sections.

5.2.6 Users characteristics results

As mentioned earlier, the main objective of the experiment’s preparation phase was to find test participants with various backgrounds and professional occupations. The objective was successfully met as illustrated in the following section that some of the participants were aged between 30 and 39 years old, while the majority was aged between 20 and 29 years old.

![Users' Age](image)

Figure 5-6: Users’ Age
Concerning the participants’ gender, it came out that more female users participated in the evaluation, in percentage 67%.

**Figure 5-7: Users’ gender**

All the participants turned out to be highly educated; all of them had at least completed a university degree, while 60% of them had completed postgraduate studies as well.

**Figure 5-8: Users’ education**
As mentioned earlier, participants’ professional background was very important to the research. It was expected to get different results from the three user categories, in relation to their performance and especially to the satisfaction questionnaires. As it is shown in the chart below, there was the same number of participants for each one of the three categories.

**Users’ occupation**

![Users' occupation chart](chart.png)

**Figure 5-9: Users’ occupation**

The information presented below depicts the users’ score concerning computer use, task experience and attitude. Regarding the computer use, as one may see in the charts below, the majority of users could be characterized as experienced users. In fact, 60% of them were very experienced and 27% were just experienced in using a computer. However, there were certain cases of users who were not so familiar with computers, due to which the average score was lowered and the standard deviation increased. More specifically, the average computer use score for all the participants was 4.06 (indicating that average of the participants were experienced) and the standard deviation was 0.98 while the maximum expertise score was 5 and the minimum 1.66.
In relation to the participants’ expertise regarding the test tasks, it turned out that the majority of participants were inexperienced. More specifically, none of them was very experienced, 13% only were experienced, 7% moderately experienced, while 47% were little and 33% very little experienced.
Last, but not least was the issue of participants’ attitude. The results indicated that all participants, even those with less experience, were positive towards computers in general and towards using a computer in their professional occupation. As one may see in the pie chart below, 40% of the participants were very positive, 53% were positive (thus the generally positive participants were 93%), 7% were neutral and no one was negative or very negative. Having positively thinking participants evaluate a product, means that they would generally not criticize the product under evaluation; their comments and suggestions are well-intentioned in order to help the product’s improvement.
5.2.7 Evaluation criteria

The most important part for planning a user testing evaluation is to define the purpose of the evaluation and determine specific objectives to be explored during the evaluation. In the case of WebPro, the main objective of testing was to find out how potential users will feel when using the tool and more specifically if they will be able to work effectively and efficiently. In order to determine whether the system will finally be usable, it was decided to study the following characteristics of the participants’ performance:

- Time to complete each task.
- Number and percentage of tasks completed correctly (and without assistance).
- Number and percentage of tasks completed incorrectly.
- Number and percentage of tasks completed with assistance.
- Number of errors.
- Number and percentage of errors that were corrected.
- Number of omissions.
Additionally, participants should be able to express their opinion regarding some system characteristics, such as the overall ease of use and learnability of the product, as well as the ease of use and individual satisfaction regarding specific system features, such as the projects, the document area and the calendar. In order to help users express their opinions, a satisfaction questionnaire should be created that participants would fill-in once they have completed the test.

5.2.8 Results

During each evaluation session, the computer screen as well as the facial expressions of the user were recorded, in order to help the subsequent study of the data. By using the computer screen recordings it was possible to record metrics related to each user’s performance, e.g., the time required to complete each task, the errors made and whether they were corrected, or the number of times that the user asked for assistance.

All these measurements are presented in this section, in order to obtain an overview of the participants’ performance. Studying the aforementioned characteristics of a participant’s interaction with the system for each one of the tasks, it is possible to locate any cumbersome or difficult to use system features and suggest potential improvements.

The charts in Figure 5-13 to Figure 5-17 are related to the time that was required for each participant to carry out a task. The measurement does not necessarily imply that the participant completed without any errors or assistance the specific task. In case that a participant did not carry out a task at all, the time is indicated as 0. In case that the participant carried out the task but not completely, the time is recorded and presented in the chart with a dark red colour. This helps obtaining a complete overview of the situation.

The graph in Figure 5-13 presents the time required for all participants to carry out the task in the first part of the scenario. The task was considered to be successfully carried out if a user could meet all the required criteria. As appears in the chart, all participants carried out the task successfully. The minimum time required was 2.05 minutes, while the maximum was 5.04 minutes. The time required for each participant to locate the necessary information (links, buttons, etc.) for each subtask, as well as the time required to carry out the subtask itself, was measured in order to identify the information that was more difficult to find.
The second task that users were instructed to carry out was to add an event to their calendar and then edit its characteristics. In order to successfully complete the task, a participant should select the link named “My calendar”, locate the option “Add”, fill in the appropriate form and finally locate the “Edit” option in order to change the event details. The results in the chart of Figure 5-14 show that the minimum time required was minutes 1.35, while the maximum was 3.01 minutes.
The third task that the users were instructed to carry out was to find a specific project task, read the related information, move the selected task under another task and finally assign it to themselves. This task was considered successful if a user managed to carry out all the required steps. The results in the chart of Figure 5-15 show that the minimum time required was 4 minutes, while the maximum was 7.03 minutes.

![Time to complete Task3](image1)

**Figure 5-15: Time to complete task3**

The fourth task that the users were guided to carry out was to read their personal timesheet for a specific period and fill in the daily journal for a specific task. In order to successfully complete the task, a participant should complete both sections. As depicted in Figure 5-16, the minimum time required was 2 minutes, while the maximum was 4.07 minutes.

![Time to complete Task4](image2)

**Figure 5-16: Time to complete task4**
The fifth task that the users were instructed to carry out was to edit and upload a document and then to move a folder and a document to another folder. In order to successfully complete the task, a participant should complete all subtasks. According to the results in Figure 5-17 the minimum time required was 2 minutes, while the maximum was 4.05 minutes.

![Time to complete Task5](image)

**Figure 5-17: Time to complete task5**

### 5.2.9 Results of the Post-Test Questionnaire

As described in section 5.1.4, the results gathered through the post-test questionnaire are used to calculate four factors. The OVERALL factor expresses the overall satisfaction of the users regarding the system. The SYSUSE factor measures the satisfaction of users when using the system, while the INFOQUAL measures the information quality provided by the system. Finally, INTERQUAL is a factor that captures user satisfaction regarding the interface provided by the system. Figure 5-18 represents the OVERALL factor for each of the ten participants, clearly showing that the users were generally satisfied (60% stated that they are satisfied and 20% very satisfied) by the overall usability of the system. However, there is a 20% of the users that are medium satisfied.
In Figure 5-19 the SYSUSE factor is presented for each user based on the opinion of the participants. In general, 70% of the users were satisfied, 20% were very satisfied and 10% seemed to have more requirements regarding system’s quality of use.
The INFOQUAL factor for each participant is presented in Figure 5-20. While 70% of users were generally satisfied about the information quality, another 30% were very satisfied.

![Factor INFOQUAL](image1)

**Figure 5-20: Factor INFOQUAL by participants**

The INTERQUAL graph for each participant is presented in Figure 5-21. 60% of the users were satisfied with the quality of the user interface while a 30% was very satisfied and a 10% of the participants appeared to be more or less satisfied.

![Factor INTERQUAL](image2)

**Figure 5-21: Factor INTERQUAL by participants**
6 Conclusions

The main objective of WebPro is to provide managers and projects participants a system that enables them to cooperate over the Internet effectively and efficiently even if the project members are located in different geographic locations and both formal and informal communication facilities are required. Informal communication is achieved with the help of facilities such as message boards and chats, respecting user privacy. Formal communication is achieved with the use of various mechanisms such as real time notifications that are sent by the system to selected users according to the issues that affect their work. Additionally, other facilities, such as document-areas, enable users to share project documents and files and work towards the production of project deliverables. WebPro also aimed at the provision of the required facilities for the project managers in order to administer their projects, acquire resources and maintain a general overview of the project progress and members. This multiple objective is achieved in WebPro through the implementation of various project administration facilities, such as project statistics, members’ journals and time reports, etc.

The development of WebPro adopted a user-based design approach that provided a usable and well-designed system meeting the initial objectives. The first step of the development was the identification and collection of user requirements that were subsequently analyzed in order to graphically represent the interaction scenarios for using the system with the help of hierarchical task analysis. These scenarios were transformed into design mock-ups for initial expert and user evaluation and subsequently, the development of the system initiated, implementing all the required components and functionality. Finally, heuristic and user based evaluation was carried out in order to identify potential usability problems of the implemented prototype. The analysis of the evaluation results provided the appropriate feedback for redesigning some aspects of the final WebPro prototype.

6.1 Future work

Software development is a very demanding process and the outcomes are always outdated since a system that meets user requirements today cannot satisfy user requirements after a year or two. Thus, in order to continuously preserve user support and satisfaction, a constant effort to improve WebPro should be adopted for maintaining and extending existing functionality but also for adding new components that will satisfy new user requirements.

There are several other mechanisms that can be embedded in WebPro and facilitate project administration:

- Cooperative editing is a feature that can help project members to cooperate on the creation of all the project documents and deliverables facilitating discussion on a specific part of a document or revision of a whole document.

- A mechanism that creates scheduled network charts is also considered an important tool that assist project administration since it provides project managers with the ability to examine the interrelationships between various tasks.
(e.g., which task need to be finished before another one can start). An example of a schedule network chart is presented in Figure 6-1, showing that in a software development project the task analysis phase requires the previous completion of the requirement analysis phase. On the other hand, the interface and database can be implemented in parallel. The basic advantage of schedule networks charts is that they can be used to identify and track the critical path of a project. The critical path is the set of tasks along the path that takes the longest time to complete [2]. Thus, the critical path determines when the project will be completed. The tasks on the critical path require special management attention because any delay in these tasks leads to a corresponding delay in the project completion date. The critical path is also useful as a risk management factor because a potential delay of project schedule can be easily identified.

Figure 6-1: Schedule network chart
Many project administration systems were designed in recent years with the aim to address the needs of project members. This provides evidence that particular interest exists in many companies and large organisations for using such tools. Nevertheless, these tools are not as widely used as expected, and this is attributed mainly to the complex tasks that they support or to the unfriendly user interface that they have. Therefore, user-friendly and usable systems can enable stakeholders with little experience concerning project management to work efficiently and effectively taking advantage of the complex functionality of such a computerised system. The WebPro system focuses on the human-computer interaction aspects of a project administration system in order to promote the usability in this category of tools and offer a more usable working platform.
7 Reference


Appendix I. Evaluation: questionnaires and use scenarios
1. Background Information Questionnaire

Evaluator: ________
With the help of this questionnaire (which starts in the next page), we intend to gather information on the background of the users who will participate in the “WebPro” usability evaluation. This is an anonymous questionnaire and the information that you will provide will be used for statistical reasons only, in order to help us create a profile of the evaluation participants and thus understand better their behavior and performance. Usually it is best to respond with your first impression, without giving a question much thought. Your answers will remain confidential.

Thank you for your cooperation!
A. GENERAL INFORMATION

1. **Age**: Into what category does your age fall?
   - [ ] 20 – 29
   - [ ] 30 – 39
   - [ ] 40 – 49
   - [ ] 50 – 59
   - [ ] 60+

2. **Gender**
   - [ ] Male
   - [ ] Female

3. **Education**: Please check the highest grade level achieved
   - [ ] Primary School
   - [ ] High School
   - [ ] Senior High School
   - [ ] University
   - [ ] Post Graduate

4. **Occupation**: Please define your professional occupation

B. COMPUTER USE

1. **How often do you use a computer?** Please check one of the following:
   - [ ] Less than twice a month
   - [ ] Twice a month
   - [ ] Once or twice a week
   - [ ] Three or four times a week
   - [ ] Daily
   - Other:

2. **Why do you regularly use a computer?** Please check all that apply:
   - [ ] E-mail
   - [ ] Word processing
   - [ ] Web surfing
   - Other:
3. If you use a computer for web surfing, have you ever visited a web-based project administration tool?

4. Are you a member of an online project team?

5. Have you ever used one of the following services? If yes, please indicate how often: daily, weekly, or occasionally?
   - Message Board
   - News
   - Chat
   - Products' Showcase

6. Generally, how well can you operate a computer? Please check one of the following:
   - Very well
   - Well
   - Moderately well
   - Little
   - Very little

7. For each one of the statements below, please check the number, which best shows how you feel. (1 = Strongly Disagree, 5 = Strongly Agree)

   a. I enjoy doing things on a computer
   b. I can learn many things when I use a computer
   c. I think that computers are very easy to use
   d. I feel comfortable working with a computer
e. Computers do not scare me at all
f. I think that computers can greatly help me with my job
g. Computers can be exciting
h. Computers can improve education
i. Using a computer prevents me from being creative
2. Interaction scenarios

**Task 1:** Navigate to URL: [http://localhost/webpro/](http://localhost/webpro/).
   1. Login to portal by username “project” and password “WebPro”.
   2. Create a project named “project1” and fill all the appropriate
details for it as you wish.
   3. Invite two random members to your project.
   4. Create in this project a task named “Task1.1” and leave it
unassigned.

**Task 2:** In “project1” go to the calendar domain and then execute the
following steps:
   1. Add a project event to the project calendar.
   2. Then edit this project event and
      a. Change its name, duration and date.

**Task 3:**
   1. Find “Task1.3.1”.
   2. Read all the information related to it.
   3. Move this task to “Project2”, as “Task2.1” subtask.
   4. Assign this task to yourself.

**Task 4:**
   1. Navigate to “Project2”
   2. Go to “Task2.1”
   3. Read your timesheet from 01/01/2004 to 03/02/2004.
   4. Add your daily journal about the above task with two hours work
duration and notes “Testing...”

**Task 5:**
   1. Navigate to “Project3”.
   2. Go to the documents area.
   3. Open “Folder1”.
   4. Upload a document to the above folder.
   5. Move “Folder2” with all its subfolders and documents to “Folder3”.
   6. Remove “Document4” from “Folder4”.
   8. Download “Document4”
3. Questionnaires

Usability evaluation questionnaire

Evaluator: ________
With the help of this questionnaire (which starts in the next page), we intend to give you the opportunity to express in what degree you are satisfied by the system usability. Your answers will help us locate the parts of the system that were easy or difficult for the user. While answering the questions have in mind the tasks you carried out. These questions explicitly concern the project management system and the applications used in order to evaluate it. Please read every claim and note the degree of your agreements by circling the grade of your choice. The grade scale is between 1 and 7 where 1 means you totally agree with the claim and 7 that you totally disagree. If you believe that a claim is not applicable to the system you evaluated circle the point N/A that means not applicable.

Thank you for your cooperation!
1. Generally I am satisfied by the system easiness.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Comments

2. I found it easy to use the system.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Comments

3. I can effectively carry out my assignment by using the system.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Comments

4. I can carry out my assignment quickly by using the system.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Comments

5. By using the system I can carry out my assignment effectively.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>N/A</td>
</tr>
</tbody>
</table>
6. I feel comfortable by using the system

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7 N/A</td>
<td></td>
</tr>
</tbody>
</table>

Comments

___________________________________________________
_____________________________________________________________
_____________________________________________________________

7. It was easy for me to use the system

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7 N/A</td>
<td></td>
</tr>
</tbody>
</table>

Comments

___________________________________________________
_____________________________________________________________
_____________________________________________________________

8. I believe that I quickly became productive by using the system

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7 N/A</td>
<td></td>
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</tbody>
</table>

Comments

___________________________________________________
_____________________________________________________________
_____________________________________________________________

9. System provides error messages that clearly state how to solve the problems.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7 N/A</td>
<td></td>
</tr>
</tbody>
</table>

Comments

___________________________________________________
_____________________________________________________________
_____________________________________________________________
10. It is for me to recover by possible mistakes.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Comments ________________________________________________________________

11. The information provided by the system such as messages on the screen or other text messages are clearly presented.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Comments ________________________________________________________________

12. It is easy to find the information I need.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Comments ________________________________________________________________

13. The information provided by the system is comprehensible.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Comments ________________________________________________________________

14. Information provided is effective in order to carry out my assignments and use scenarios.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
15. The information structure on system screen is clear.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Comments

16. The user interface is enjoyable. User Interface is the aggregate of system characteristics that allow user to interact with it.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Comments

17. I am pleased using the system’s user interface.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Comments

18. The system has all the functions I expected.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Comments
19. Generally I am satisfied by the system.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Comments

_________________________________________________________________________
_________________________________________________________________________
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