Best practice for selecting software to support NPD process management

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Abstract: The use of software solutions is one way to improve NPD processes. However, this practice is still underestimated due to the lack of a comprehensive selection process of software toward the necessities of SME´s NPD. Therefore, this paper presents a method that allows SME to analyze and select software, on their own, which supports NPD processes. The method systematizes the search of empirical knowledge about NPD best practices. This knowledge may be updated by a community of practices based on previous experiences of selecting and applying new solutions to NPD. This can be reused as a background for enterprises to define their criteria without starting from the very beginning. This paper also reports an empirical application which highlights the criteria used to select the software.

Keywords: NPD best practices; tool selection, reference model.

1. Introduction

Today's small and medium technological enterprises (SMEs) are organizing into networks so as to (1) increase their visibility in the marketplace, (2) share experiences, knowledge and abilities and (3) seek new ways to reduce costs. Nonetheless, there remains the challenge of promoting ways to enable these enterprises to work collaboratively and, at the same time, carry out their projects as effectively and efficiently as possible.

The literature indicates two trends: (1) the adoption of NPD reference models; and (2) implementation of tools that can support this process. Many NPD process reference models may be found in the literature such as the Stage-gate Process (COOPER, 2001), Pahl & Beitz Model (PAHL; BEITZ, 2003), Product Design and Development Model - PDDM (ULRICH; EPPINGER, 2004), and PDPnet Model (ROZENFELD et al., 2006). In addition, there are many new tools and software supporting product development management.

The application of tools and techniques are key factors to continually improve NPD processes. However, this practice is still underestimated due to two factors: (1) adoption and (2) diffusion of NPD tools. Adoption is related to the decision whether to use a tool or not, whereas diffusion is the cumulative number of enterprises that have adopted this tool (CHAI, 2006; NIJSSEN; FRAMBACH, 2000).

Nijssen and Frambach (2000) concluded that an enterprise should get outside assistance (e.g., from consultancy or market research agencies) in selecting a useful tool and getting acquainted with it. However, although large enterprises usually contract consultancy firms to evaluate and indicate solutions that best suit their requirements, this may not take place at technological SMEs. While they may not be able to afford external consultants, they still need to adopt tools and software that best meet their financial, cultural and technological requirements.

Fortunately, a lot of free software that supports NPD can be found on the Internet, thus, SMEs can take advantage of them to improve their NPD processes. Nevertheless, it is vital that these SMEs have a method to analyze and select software on their own (i.e., that will assist them in choosing the solution that best suits their needs).

This paper presents a method to analyze and select software (MASS) that supports NPD processes. This method have been published on the Internet to be used by SMEs free of charge allowing them to analyze and select software by themselves. The paper reports one application of the method in a network of technological enterprises. Where the criteria used in this application is highlighted. This criteria respect to the following software solution: project management (PM), knowledge management (KM), and customer relation management (CRM). It also provides practical experiences and lessons learned.

In literature review are discussed the importance of reference models as way of improving NPD processes. In following the proposed method and the empirical results are described. Finally are presented the conclusions and future works.

2. Literature review

New product development is a business process carried out by a group of people to transform data on market opportunities and technical possibilities into information to assist the design of a commercial product (CLARK;

FUJIMOTO, 1991). According to Ulrich and Eppinger (2004), NPD processes may be considered as a sequence of steps or activities employed by an enterprise to conceive, design, and commercialize a product. As these activities exchange information with each other (BROWNING; EPPINGER, 2002), this process demands the cooperation of people with varying expertise and level of experience and from different departments of the organization. Consequently, effective communication is a sine qua non in the management of the NPD activities as a continuous learning process (SÖDERQUIST, 2006; BRADFIELD; GAO, 2007).

Some of the NPD characteristics are: high levels of uncertainty and risk in activities and results; important decisions made in the beginning of the process when uncertainty is higher; manipulation and generation of large amounts of information; activities and information deriving from many source; and multiple requirements considering all product lifecycle phases and customers' needs (ROZENFELD et al., 2006).

The effectiveness of a NPD process must be a primary goal of all enterprises because it is a critical business process in improving their competitiveness, diversity and product mix—especially in the international market—and reducing product lifecycles (BÜYÜKÖZKAN; BAYKASOGLU, 2007; ROZENFELD et al., 2006). However, an efficient NPD management demands that the process should be visible to all stakeholders (COSTA et al., 2007), which may be achieved by business process modeling and publishing, for instance, in the enterprise's intranet. This results in a map or representation that describes the company's business process (PERNICI; WESKE, 2006), known as the business process reference model.

A reference models is a collection of best practices and should be adapted to the company's NPD maturity level. It can also be employed to benchmark new improvement projects. A generic reference model is usually developed for one industry sector, but may be used in other sectors. That is to say that enterprises pertaining to the same sector can establish their standard process models by adapting the generic reference model to their current NPD situations.

Some of the more cited NPD reference models are: Stage-gate Process (COOPER, 2001), Pahl & Beitz Model (PAHL; BEITZ, 2003), Product Design and Development Model (ULRICH; EPPINGER, 2004), CMMI (CHRISSIS et al, 2004). For the case reported in this paper all the reference model cited above were analyzed, however the PDPnet (ROZENFELD et al., 2006) was analyzed in depth.

The PDPnet model synthesizes the best NPD practices. It highlights the integration of strategic planning and portfolio management; the incorporation of PMBOK concepts (PMI, 2004) into the planning phase; the definition of integrated cycles for the detailing, acquisition and optimization of products in the detailed design phase; the insertion of optimization activities; and the integration of product launching phase with others business processes, such as technical assistance and sales processes, are defined and implemented.

The varied activities inherent to the reference models may be supported by tools to improve the enterprise's NPD performance. Choosing a tool depends on: knowing the best time to apply it; its capacity to yield results; its dependence on the category of the products being developed and the necessary resources. This represents an additional difficulty to everyone involved in product development because it increases the complexity of management.

Computational technologies are being increasingly employed in product development. However, this may restrict the enterprise's operation to the software in use. Therefore, it is crucial to define structured and systematic procedures to assist enterprises in selecting tools (computational solutions to implement techniques and methods) that best meet their needs.

3. Method of software analysis and selection (MASS)

The scientific approach used in this work was the hypothetic-deductive method, since each application tries to refute the hypothesis. The hypothesis was that the method in question may help companies to select software that support their NPD processes.

As aforementioned, enterprises need to constantly seek out for new software that meets their specific requirements. The method presented in Figure 1 is a proposal to help them to evaluate and select these solutions. So, the first phase of the proposed method is aimed at elaborating a list of requirements. The enterprises' specific requirements are gathered by mean of interviewing people who perform the related activities. However, SME may be not able to define all the requirements by itself. For this they should investigate web data base that contains a consolidation of requirements. For instance, the analysis of reference models best practices will indicate possible requirements for a solution. Empirical knowledge should also be investigated because specialized journals, websites and magazines reports real cases. This investigation can assist these companies in preparing an initial list of requirements for the software that they are seeking. The phase review follows the requirement definition in the Gate 1, whose objective is to evaluate whether the quantity and quality of defined requirements suffice for the next phases.

The goal of the second phase is to produce criteria that will be used in the software evaluation. To this end, two activities must be carried out. The first one is to analyze the enterprise's NPD process and search for others specific requirements, which are sine qua non conditions for the selected software to work efficiently and effectively (e.g.,

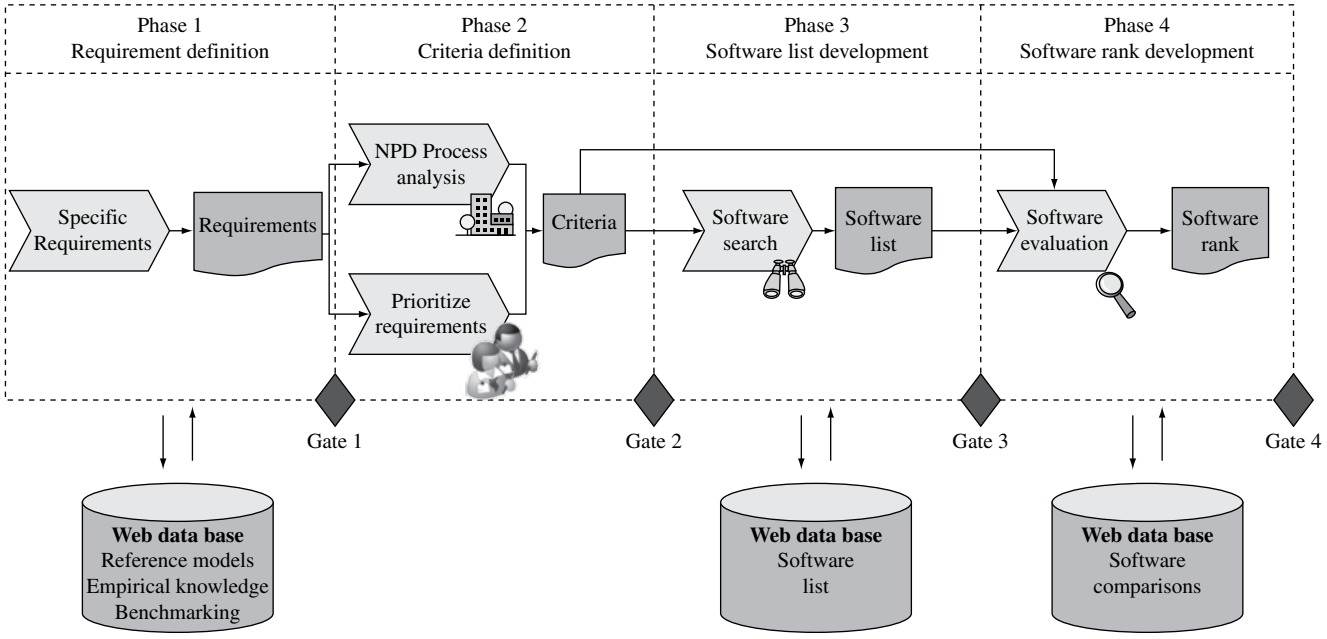


Figure 1. Method to analyze and select software (MASS) that supports NPD processes.

non-functional requirements such as data base, programming language and software cost). The other activity is to give priority to the requirements. This is achieved by mean of an interview with the larger number of collaborators as possible. This interview aims at defining the degree of importance of each requirement and to provide people with the opportunity to participate in the software selection process. This activity is very important to guarantee their support in the implementation phase as they will be the ones to use the selected software in the future. The result of this phase, which must be evaluated in Gate 2, is a list of criteria that will be the software search and evaluation basis.

Phase 3 focuses on systematically searching the web data base for software that meets the developed requirements (Figure 1). Therefore, the key words for this search have to be well defined so as to promote an efficient search. In this search some of the software found may already be eliminated in accordance with non-functional and other criteria by verifying their documented features available on the Internet. This initial elimination should be recorded on a spreadsheet, describing, as thoroughly as possible, these tools and why they were refused. The main result of this phase is a list of software to be evaluated in Phase 4. This list must be considered in Gate 3. It is important to ensure that at least a few software programs are found and analyzed to guarantee that none of the software discarded should have gone to the next phase.

The goal of Phase 4 is to evaluate the listed software in depth. Verify the existence of comparison of solutions reported in web data base contribute to improve this evaluation (Figure 1). However, technical people should be involved whenever necessary, (i.e., to install required programs and data bases). This involvement ensures the best performance of the software in question. All of the criteria must be analyzed and numerical scores must be attributed for each one of them. Once the evaluation is finished, the comparison may begin. The degree of importance of the criteria, as defined in Phase 2, will serve as the basis for this comparison. Finally, the software evaluated is ranked so as to assist in deciding which software should be implemented. This definition must be validated in Gate 4 to guarantee that the enterprise's strategy and polices are ensured.

Once the software is chosen, it is very important to develop an implementation plan. For this purpose, it is recommended to adopt a change management method, which will assist in (1) checking performance indicators before and after the implementation, (2) the definition of the implementation plan, and (3) the training of people involved in the change. In the case that the company has a business process management (BPM) approach, this method should be integrated to it (COSTA, 2007).

In following section a practical application of the proposed method is reported.

4. Pratical resuts

It is widely known that companies are being increasingly challenged to continually improve the quality of their processes and products. In view of this, a pool of technological enterprises in Brazil, organized in a network, saw the need to adopt software that would support their NPD process and also help them to develop collaborative projects.

This network was composed of eight Brazilian technological enterprises and a research laboratory at Sao Paulo University. This joint work was aimed at systemizing and organizing collaborative NPD processes and sales processes of on-demand products. In order to accomplish the project goals, sub-projects were established. One of them was to develop a method to select and analyze software that supports NPD processes, described in this article. The systematization of some NPD process activities was the focus of their NPD process improvement goal, so the quality improvement of their products would be assured by achieving this goal.

The enterprises participating in this sub-project were: Cia1, a web developer; Cia2, an embedded software developer; and Cia3, a dosimetry laboratory. Two research laboratories were also involved: Lab1, a research group focused on NPD management with 30 researchers; and Lab2, an organization supported by a Brazilian science and technology agency that congregates 600 researchers from 39 research groups.

These enterprises developed a project plan whose goal was to assess 3 categories of software: (1) project management (PM) software; (2) content management (CM) software; and (3) customer relationship management (CRM) software. The team was composed of people from each enterprise as well as people from Sao Paulo University. The team was divided into three small groups in charge of one of the 3 software categories: PM Group, CM Group and CRM Group. The following section presents each phase of the proposed method as it was carried out in this project.

4.1. Phase 1 – Requirement definition

The first phase of the method proposed began with the search of information about the best practices of the areas pertaining to the three software categories. This information, which composed the list of requirements, was based on two sources (Figure 2):

- Product development management standards: CMMI (CRISSIS et al., 2003); PDP net reference model (ROZENFELD et al., 2006); and PMBok - Project Management Body of knowledge (PMI, 2004);
- Published empirical knowledge: PhD thesis and practical cases published in academic journals (WHITE; FORTUNE, 2002; HAMERI; PUITTINEN, 2003; BARNES et al., 2006; RODRIGUEZ; Al-ASHAAB, 2005).

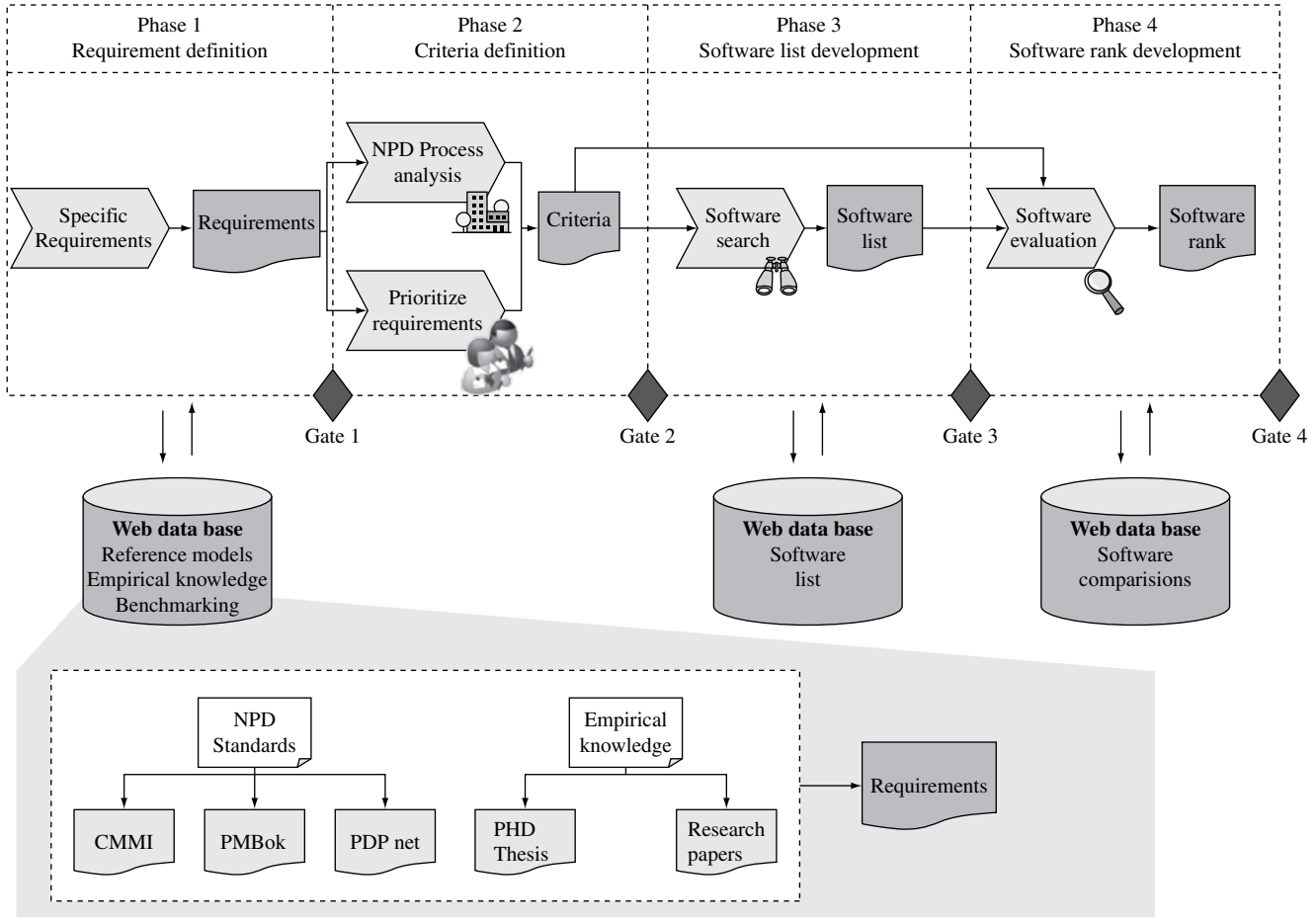


Figure 2. Phase 1 – Requirement definition.

In addition, it was assumed that analyzing proprietary project management software would be necessary because PM systems embrace several best practices. Therefore, two PM systems were analyzed, MSProject Professional 2002 and PMOffice 2000.

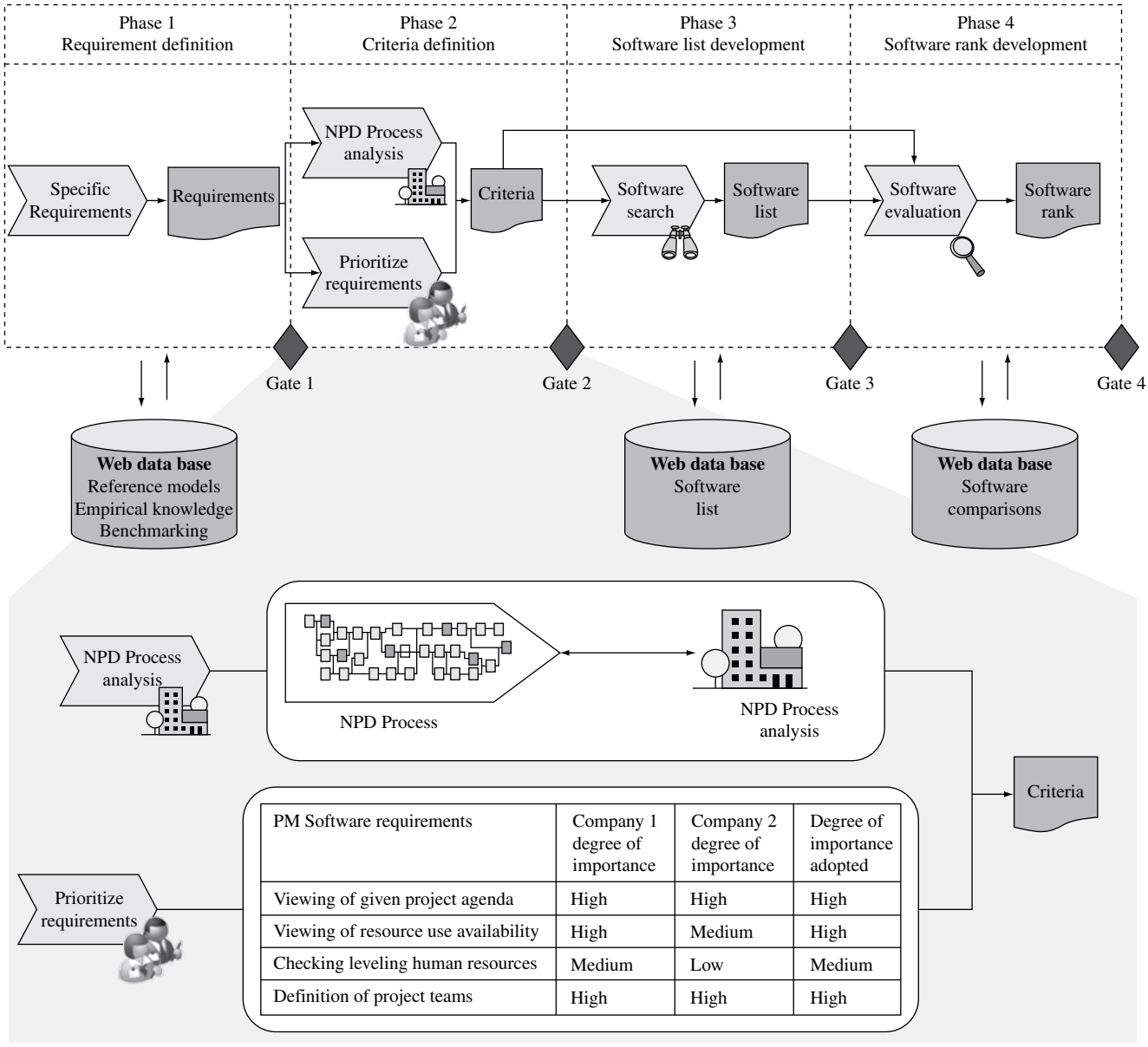
The next step was to compile the data into a list of requirements (see requirement column of Tables 1, 2 and 3 in Appendices 1, 2 and 3), which were analyzed in Gate 1. Two project management specialists were invited to perform this analysis. After their approval Phase 2 was started.

4.2. Phase 2 – Criteria definition

Firstly, the three groups carried out an analysis of the activities performed on each enterprise's NPD (Figure 3). This analysis took into account the enterprises' NPD maturity level. The PM Group was in charge of analyzing the project management practices at Lab1, Lab2, Cia1 and Cia2.

The CM Group investigated activities related to how Lab2, Cia1 and Cia2 released NPD project-related documents, templates and other information related to their collaborators. This group also looked for practices that might disseminate knowledge and lessons learned across departments.

The CRM Group analyzed the practices performed by Cia1, Cia2 and Cia3 NPD process aimed at gathering information about their customers as well as about their



PM Software requirements	Company 1 degree of importance	Company 2 degree of importance	Degree of importance adopted
Viewing of given project agenda	High	High	High
Viewing of resource use availability	High	Medium	High
Checking leveling human resources	Medium	Low	Medium
Definition of project teams	High	High	High

Figure 3. Phase 2 - Criteria Definition.

relationships, (e.g., how their clients called for new features, informed about bugs and deadlines).

Once NPD process analyses were completed and specific requirements were included into the requirement list the team was able to define their degree of importance, which was influenced by the enterprises' maturity level. Then, the groups went back to their enterprises and laboratories to interview key collaborators, the ones that would use the software after implementation. This was done through a spreadsheet that contained all the requirements (Figure 3). The interviewees were asked to define the importance level of the requirements for their enterprise or laboratory.

Because the proposed method was carried out within a network of technological enterprises it was important to fully meet all of their needs. Therefore, the highest degree of importance regarding a given requirement was the one adopted as the basis for comparison (see table in Figure 3). Afterward, a numerical correspondence was assigned to for each degree of importance: high = 5, medium = 3, low = 1, and null = 0.

The result of this phase was the establishment of criteria (see Appendices 1, 2 and 3). Their validation was carried out in Gate 2 by means of a meeting with the enterprises' board of directors and the laboratories' chief researchers.

4.3. Phase 3 – Software list development

The first activity performed in Phase 3 was stating the key search words. For PM software there were defined "project management"; "project planning"; and "product development planning". For CM software: "contented management"; "product data management"; "electronic data management"; and "knowledge management". For CRM software: "CRM"; "help desk"; and "client management". All searches were carried out using a combination of these key words and the following terms: "tools", "solution", "system", "software" and "free software".

The search instructions on the web data bases were: (1) start recovering information found in Phase 1 about software analyzed in papers, white papers or PhD theses; (2) look into well known websites such as http://freshmeat.net/ and http://sourceforge.net/; and (3) search the Internet engines. The groups also were advised to collect and register all of the software specifications that met the criteria. Appendix 4 presents the list of the software solutions.

It was also possible to evaluate some criteria before Phase 4. Therefore, non-functional criteria could be evaluated by means of the information available at the software web sites. This first evaluation eliminated a lot of the software found in this phase. A second elimination of inadequate software was carried out, after Phase 4, through the analysis of their features, which were also available at their web sites as well as in their documentation (guides) (Figure 4).

Out of a total of 27 PM software programs, only eight were selected. In the case of CM and CRM software, only 5 out of 34 and 4 out of 20 were selected for next phase, respectively.

4.4. Phase 4 – Software rank development

This phase aimed at promoting an in-depth evaluation of the software selected in the previous phase. To this end, all of the 17 tools were installed (how easily they could be installed was also evaluated). The criteria were evaluated and graded from 0 to 5 (Figure 5). Grade 0 was assigned to the software that did not have the requirements in question and Grade 5 was attributed to the software that fully meets the criteria. The in-between grades were attributed in accordance to how thoroughly the software met the criteria. As a way of making this evaluation explicit, the groups were instructed to explain why they gave those grades.

The scores received were multiplied by the importance level of each criterion (i.e., high = 1, medium = 0.6, low = 0.2 and null = 0). The results of this evaluation are shown in Appendices 3, 4 and 5. The final scores of the software solutions evaluated is reported in appendices 1, 2 and 3.

At Gate 4, the implementation of the top PM, CM and CRM software programs evaluated in the previous phase was discussed. As a way of testing the effectiveness of this software it was decided that the following implementations would be done:

- PM software – dotProject would be implemented at Cia1, Lab1 and Lab2
- CM software – ezPublish would be implemented at Cia 1 and Lab1
- CRM software – Vtiger would be implemented at Cia1, Cia2 and Cia3
- After the proposed method was executed, a change management method (COSTA, 2007) was applied to support the implementation of the selected software at the companies.

5. Conclusion

The proposed method was shown to be useful in the selection of tools that support NPD processes because applying it directed the tool searching. Finding real cases of tool implementations in journals or other publications and using key predefined words helped to increase the search efficiency. As a consequence, the list of tools found was more consistent as regards number and diversity.

A second relevant point was that the analysis of the best practices to elaborate the requirement list, by itself, contributed to improve the NPD process because during the software implementation some best practices could be incorporated into the new routine, consequently improving the processes. In the reported PM case, this was noticed at Cia1. Leveling human resources was not a previous Cia1's

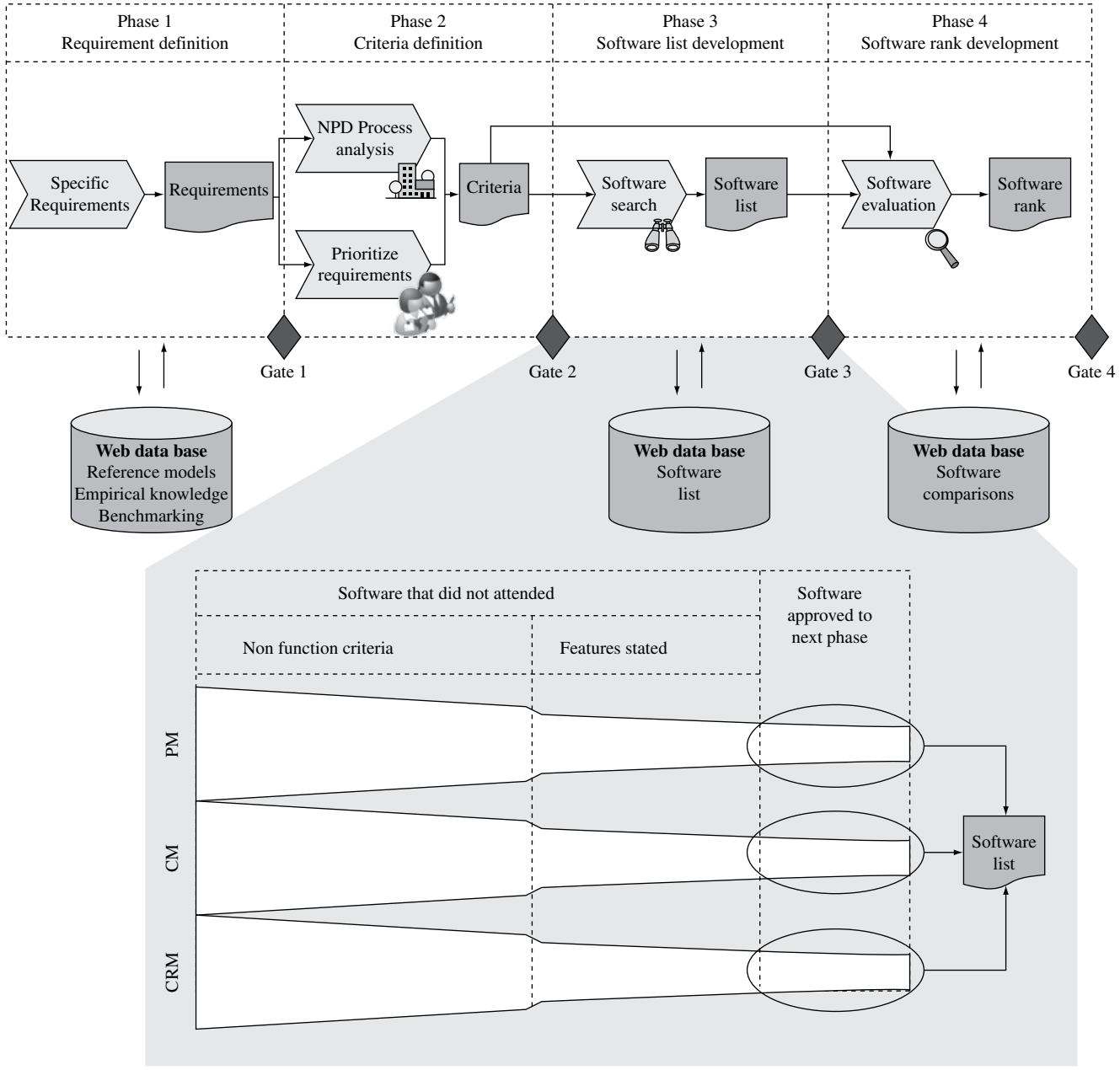


Figure 4. Phase 3 – Software list development.

goal, but when they analyzed the PM requirement list this practice was perceived as necessary. Therefore, Cia1 gave a high grade to the importance of this requirement. As a result, since this requirement was available in the selected software, they institutionalized this practice.

Another advantage of the proposed method is that it customized the software selection for users. The degree of importance of each criterion was based on the NPD process maturity level. Therefore, this customization rationalized the decision-making process. The enterprises mitigated the risk of selecting a software program that seemed to be the best choice owing to its large number of features, but it was inadequate to the company's capability. Additionally, this promoted the success of the implementation because of the reduction of possible barriers (e.g., inadequate routines, information deficiency and technical incapacity).

Another perceived benefit was that the method acted as a guide to promote NPD improvement, providing the collaborators with a sense of confidence and optimism as to the selection results. One of the reasons for this positive attitude on the part of the collaborators was the fact that (1) they realized the need to implement a new tool; and (2) they were able to participate in defining the criterion

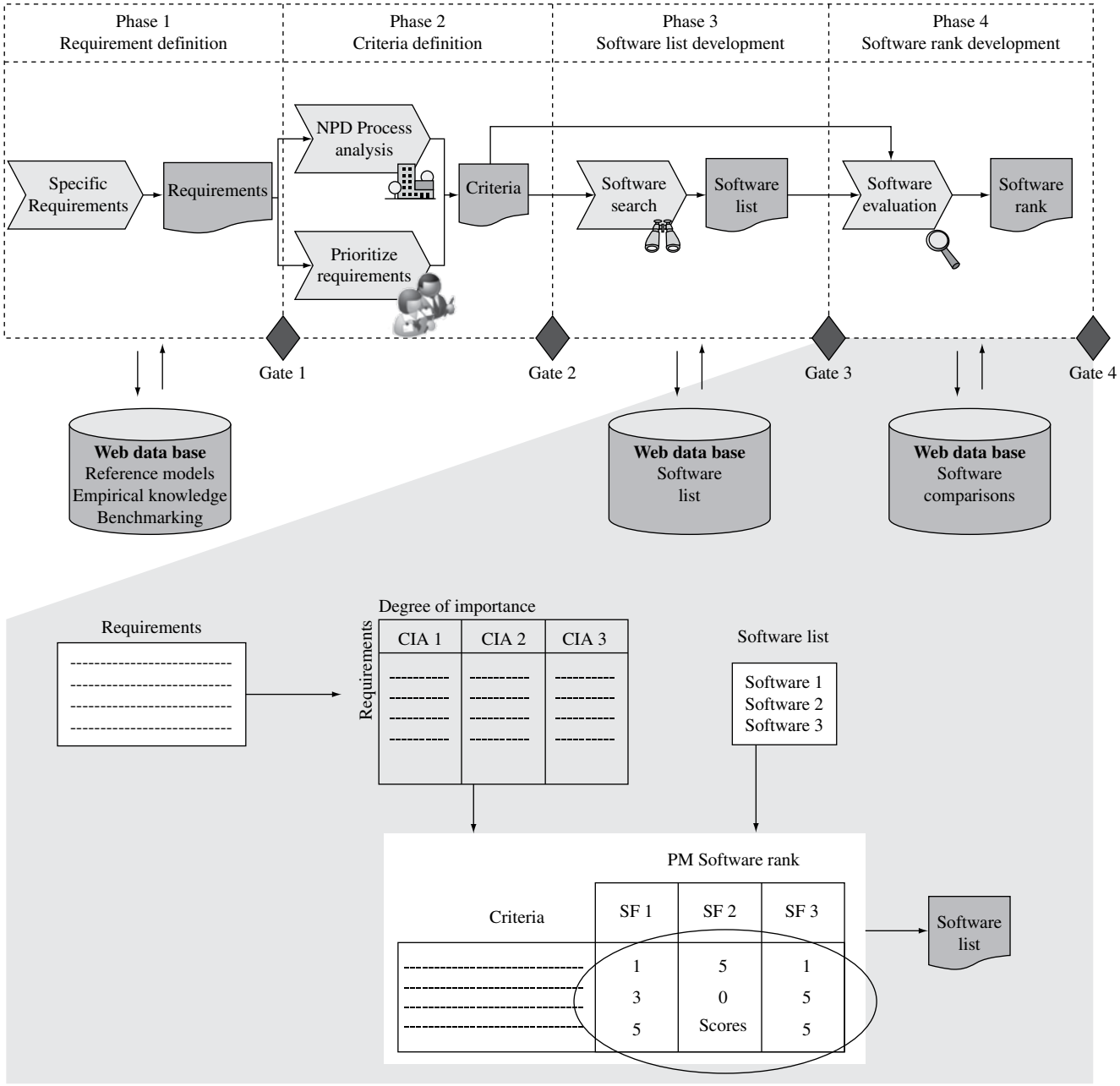


Figure 5. Phase 4 – Software rank development.

importance level, certain that their opinions were essential to successfully improve their enterprise's processes.

The use of free software in technologic SMEs has proved to be a pragmatic solution as it appears to meet most of these enterprises' requirements. This software can also be easily customized to meet specific requirements, since it is open-source.

Some of the main lessons learned are:

- The application of CRM software to on-demand NPD is important because the first requirements and product specifications come up during the sales phase;
- The PM systems more well know are proprietary systems. They have enough features to assist almost all of the processes of project life cycle management. However, the high cost of license acquisition, lack of customization capacity, extensive trainings and need for technical support hinder their diffusion. On the other hand, free PM solutions proved to be mature enough to meet SMEs' requirements ;
- Content management software facilitates NPD process visualization on an intranet and can be used as a document management system as well;

- The availability of reference models is important to guide NPD improvement projects and to guarantee a common language among network members; and
- The interaction among the enterprise collaborators during the selection process contributes to successful software implementations.

Evidently, this method has to be implemented in other contexts so that its general applicability may be assessed. Additionally, in this context it is worthwhile to work with a systematic change management method related to a broader BPM approach and the implementation of single NPD solutions should be integrated to a comprehensive PLM (Product Life-cycle Management) architecture. These two trends will be researched in future works.

The authors are grateful to the enterprise for volunteering to take part in this research, to GEI2 colleagues for suggestions and to CNPq for the financial support.

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APPENDIX

Table 1. PM Criteria evaluations.

Requirements	Degree of importance	Gantt	OpenWork Bench	Tutos	Ph Projekt	Php Collab	Dot Project	Planner
Total		**4,02**	**3,44**	**4,39**	**3,44**	**3,43**	**4,74**	**3,81**
Non-Functional Requirements		7,04	6,73	8,00	8,00	8,08	8,00	6,85
Programming Language	High	3,0	3,0	3,0	3,0	3,0	3,0	3,0
Database	High	0,0	0,0	5,0	5,0	5,0	3,0	3,0
Operational System	High	5,0	3,0	5,0	5,0	5,0	5,0	3,0
Tool Development Status	High	5,0	5,0	3,0	5,0	5,0	5,0	3,0
License	High	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Cost of license	High	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Technical Support	Medium	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Installation Manual	Low	0,6	1,0	0,6	0,6	1,0	0,6	0,6
Users Manual	Medium	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Project life-time	High	5,0	5,0	5,0	3,0	3,0	5,0	5,0
Language	High	3,0	3,0	5,0	5,0	5,0	5,0	3,0
Community	High	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Project Planning		9,04	7,02	9,57	5,74	5,64	10,96	8,40
Viewing of a given project agenda	High	0,0	0,0	5,0	3,0	0,0	5,0	5,0
Viewing of resource use availability	High	5,0	5,0	5,0	0,0	0,0	5,0	5,0
Checking leveling human resources	High	5,0	5,0	3,0	0,0	0,0	5,0	0,0
Definition of project teams	High	3,0	3,0	5,0	0,0	0,0	3,0	3,0
Elaboration of work breakdown structures (WBS)	High	5,0	5,0	5,0	3,0	0,0	5,0	5,0
Viewing of and formatting PERT graphics	Low	1,0	1,0	0,0	0,0	0,0	0,0	0,0
Viewing and formating GANTT graphics	High	5,0	5,0	3,0	5,0	3,0	3,0	3,0
Definition of sequence of activities	High	5,0	5,0	5,0	3,0	3,0	5,0	5,0
Definition and viewing of levels of activities	High	5,0	5,0	5,0	3,0	3,0	5,0	5,0
Definition of people in charge of tasks	High	3,0	0,0	5,0	5,0	5,0	5,0	3,0
Definition of the beginning and end of the tasks and/ or their duration	High	5,0	3,0	5,0	5,0	5,0	5,0	5,0
Description of necessary resources	Null	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Definition of milestones	High	5,0	5,0	5,0	0,0	3,0	5,0	5,0
Viewing of tasks with respect to resources	High	5,0	3,0	5,0	3,0	3,0	5,0	5,0
Viewing of tasks in connection with projects	High	5,0	5,0	5,0	3,0	5,0	5,0	5,0
Viewing of cost list with regard to activities	Medium	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Management of multiple projects	High	0,0	0,0	5,0	5,0	5,0	5,0	0,0
Creation of project templates	High	0,0	3,0	3,0	0,0	0,0	5,0	0,0
Creation of activities templates	High	0,0	3,0	0,0	0,0	0,0	5,0	0,0
Importation of projects and tasks	High	5,0	0,0	3,0	0,0	0,0	5,0	5,0
Exportation of projects and tasks	High	5,0	0,0	0,0	0,0	3,0	5,0	5,0
Baseline	Medium	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Verification of progress of executed activities as compared to planned activities	High	5,0	5,0	5,0	5,0	5,0	3,0	5,0
Recording of evaluation results relating to tasks/ deliverables	High	0,0	0,0	3,0	3,0	0,0	3,0	0,0
Update of schedules	High	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Reporting of changes (events) to those interested (by email)	High	3,0	0,0	5,0	3,0	5,0	3,0	5,0
Aggregation of value review	Low	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Generation of monitoring reports	High	5,0	0,0	0,0	0,0	0,0	3,0	0,0

Table 2. CM Criteria evaluations

Requirements	Degree of importance	Plone	Joomla	Simplify	Ez Publish	Tikiwiki
Total		**7,48**	**6,44**	**5,33**	**8,53**	**6,41**
Non-Functional Requirements		8,44	8,44	2,96	8,15	8,30
Programming Language	Medium	1,8	3,0	0,0	3,0	3,0
Database	Medium	1,8	1,8	0,0	3,0	1,8
Operational System	High	3,0	3,0	3,0	3,0	3,0
Tool Development Status	High	5,0	5,0	5,0	5,0	5,0
License	High	5,0	5,0	0,0	5,0	5,0
Cost of license	High	5,0	5,0	3,0	5,0	5,0
Technical Support	High	3,0	3,0	5,0	3,0	3,0
Installation Manual	High	5,0	5,0	0,0	3,0	3,0
Users Manual	High	5,0	5,0	0,0	3,0	5,0
Project life-time	Medium	3,0	1,8	0,0	3,0	3,0
Technical Documentation	High	3,0	3,0	0,0	3,0	3,0
Multiple users	High	5,0	5,0	0,0	5,0	5,0
Content Management		6,52	4,43	7,70	8,91	4,52
Management of different content types (file, page, link etc)	High	5,0	3,0	5,0	5,0	5,0
Management of version control	High	0,0	0,0	5,0	5,0	0,0
Keeping track of alterations	High	0,0	3,0	5,0	5,0	0,0
Inclusion of content keywords	High	5,0	5,0	0,0	5,0	0,0
Definition of content priority	High	0,0	0,0	5,0	5,0	0,0
Management of users groups	High	5,0	5,0	5,0	5,0	5,0
Publication of contents to a given group of users	Low	1,0	1,0	1,0	0,6	1,0
Definition of taxonomy for content classification	Medium	1,8	0,0	1,8	1,8	1,8
Definition of flexible meta-data	High	5,0	3,0	3,0	5,0	3,0
Submission of content to approval process (by means of workflow) - Review of contents	Medium	3,0	3,0	3,0	3,0	3,0
Check-in and check-out of contents	High	0,0	5,0	5,0	5,0	5,0
Notification of added/altered/excluded content	Medium	1,8	0,0	0,0	3,0	3,0
Viewing of contents	High	0,0	5,0	3,0	0,0	0,0
Creation of content sorting and presentation rules	High	5,0	3,0	5,0	5,0	0,0
Linking of comments to contents	High	5,0	0,0	5,0	5,0	5,0
Linking of related contents (cross reference)	High	5,0	0,0	3,0	5,0	0,0
Search for content with multiple filters	High	5,0	3,0	5,0	5,0	5,0
Navigation among related contents	High	5,0	0,0	3,0	5,0	0,0
Export of data using xml format (Parser xml)	Medium	1,8	0,0	0,0	0,0	0,0
Backup of contents	High	3,0	0,0	5,0	5,0	3,0

Table 3. CRM Criteria evaluations.

Requirements	Degree of importance	XRMS	VTIGER	Hipergate	Tutos
Total		7,71	9,51	7,06	6,43
Non - Functional Requirements		8,84	9,56	8,27	8,18
Programming Language	High	5,0	5,0	3,0	5,0
Database	High	5,0	5,0	5,0	5,0
Operational System	Low	1,0	1,0	1,0	1,0
Tool Development Status	High	5,0	5,0	5,0	5,0
License	Medium	3,0	3,0	3,0	3,0
Cost of license	Medium	3,0	3,0	3,0	3,0
Technical Support	Medium	0,0	3,0	3,0	0,0
Installation Manual	Medium	1,8	3,0	1,8	1,8
Users Manual	High	5,0	3,0	3,0	3,0
Project life-time	Low	1,0	1,0	1,0	1,0
Language	Low	1,0	1,0	0,6	0,0
Dependency, expectation	Low	1,0	1,0	1,0	1,0
Technical Documentation	Low	0,0	1,0	0,0	0,0
Multiple users	High	5,0	5,0	5,0	5,0
Community	Medium	3,0	3,0	1,8	3,0
Client Management		6,57	9,47	5,85	4,68
Management of costumers' records	High	5,0	5,0	5,0	5,0
Management of prospection	High	5,0	5,0	0,0	0,0
Management of commercial proposals	High	5,0	5,0	5,0	3,0
Management of proposals status	High	5,0	5,0	5,0	5,0
Management of visit schedules	Medium	1,8	1,8	0,0	1,8
Management of contact with costumers	High	5,0	5,0	5,0	5,0
Recording of costumers' interest in types of products	High	5,0	5,0	5,0	5,0
Recording of costumers' preferences	Low	0,0	0,6	1,0	0,0
Consulting of costumers' history	Medium	0,0	1,8	0,0	0,0
Recording of costumers' payment modes	Medium	0,0	3,0	0,0	0,0
Reporting on uses of proposals(amount)	High	0,0	5,0	5,0	0,0
Reporting on uses of proposals ($)	High	0,0	5,0	0,0	0,0
Reporting on most sold products	Medium	3,0	3,0	0,0	0,0

Table 4. Software list.

CRM Software	
XRMS	http://xrms.sourceforge.net/
VTIGER CRM	http://vtiger.com/products/crm/index.html
CRMAdar	http://www.emadar.com
Customer Touch CRM	http://www.customer-touch.com
OpenCRM Miro	http://opencrm.oezdiller.com
Anteil	http://www.anteil.com/
Compiere	http://www.compiere.org/
Daffodil CRM	http://www.daffodildb.com/crm/
Hermes	http://hermesweb.sourceforge.net/
Hipergate	http://www.hipergate.org/
SugarCRM	http://www.sugarcrm.com
Tutos	http://www.tutos.org
ManageEngine ServiceDesk Plus	http://www.servicedeskplus.com
Help Desk Online	http://www.elementool.com/?kontera
OpenPSA	http://www.openpsa.org/
Liberum Help Desk	http://www.liberum.org/
ZenTrack	http://www.zentrack.net
FireFly Help Desk	http://ovh.dl.sourceforge.net/sourceforge/opencare/firefly-1.0.2.tar.gz
Knodesk	http://knodesk.sourceforge.net/
HelpmeICT	http://helpdesk.centralmanclc.com/index.php
Contented Management Software	
Axielle Portal tool	http://ibm.ascential.com/products/axielle
BEA Weblogic Portal	http://www.bea.com
C-Abre	http://www.c-arbre.net/
Collaborative Document Management Solution (CDM)	http://www.interwoven.com/solutions/cdm/index.html
DOCEBOCms	http://freshmeat.net/projects/docebocms/
Documentum 5	http://www.documentum.com/
Drupal	www.drupal.org
Freedom	http://www.semagix.com
IBM Websphere	http://www-3.ibm.com/software/webservers/portal/
InfoImage Freedom	http://www.poten.com/?URL=show_articles.asp?id=112&table=tMentions
Intelligent Data Operating Layer (IDOL)	http://www.autonomy.com/Content/Products/IDOL
Joomla	http://www.opensourcecms.com/index.php?option=com_content&task=view&id=2097
Microsoft Netmeeting	http://www.microsoft.com/windows/netmeeting
Microsoft SharePoint	http://www.microsoft.com/sharepoint
OpenCms	http://www.opencms.org/
OpenMDV	http://mdv.sourceforge.net/
PHP-Fusion	http://www.opensourcecms.com/index.php?option=com_content&task=view&id=464
PHP-Nuke	www.phpnuke.org.br
phpwcms	http://www.opensourcecms.com/index.php?option=com_content&task=view&id=367
Plone	http://freshmeat.net/projects/plone/
Plumtree Corporate Portal	http://www.plumtree.com
Plumtree Corporate Portal 4.0	http://www.capv.com/content/News/2000/10/03/100200.9
ezPublish	http://ez.no/
Powl	http://powl.sourceforge.net/
ProjectCoordinator	http://www.projectcoordinator.net/
QuickPlace	http://www.lotus.com/home.nsf/welcome/quickplace

Table 4. Continuation...

CRM Software	
Scribus	www.scribus.net
SemioTagger	http://www.entrieva.com
Simplify (Tomoye)	http://www.tomoye.com
Sun ONE Portal	http://wwws.sun.com/software/products/portal_srvr/home_portal.html
Tikiwiki	http://freshmeat.net/projects/tiki
Tribute (Knexa)	http://www.knexa.com
Xerox DocuShare	http://docushare.xerox.com
Xoops	www.xoops.org.br
Project Management Software	
Gantt	http://ganttproject.sourceforge.net
OpenWorkBench	http://www.openworkbench.org
Tutos	http://www.tutos.org
PhProjekt	http://sourceforge.net/projects/phprojekt
PhpCollab	http://sourceforge.net/projects/phpcollab
Achievo	http://www.achievo.org
dotProject	http://www.dotproject.net
TaskJuggler	http://www.taskjuggler.org
Planner	http://developer.imendio.com/wiki/Planner
Futere	http://wolfkeeper.uklinux.net/FUTURe/
Xplan	http://vmlinux.org/xplan
ToutDoux	http://gnu.org.software/toutdoux/em/
Pmtool	http://www.willuhn.de/project/pmtoll/
Planner	http://www.imendio.com/projec/planner/
Double Choco Latte	http://dcl.sourceforge.net/
Incyte Project Manager	http:// udpviper.com/html/project.php?project=ipm
Webcollab	http://webcollab.sourceforge.net/
Netooffice	http://netoffice.sourceforge.net/index.php
Project/Open	http://project-open.com/
Project Management Interface	http://majordojo.com/pmi
Gforge Project Management Tool	http://gforge.org/
Open Work Bench	http://openworkbench.org/
Austin PM	http://austin.sourceforge.net/
Projectory	http://projectory.sourceforge.net/
Maven	http://maven.apache.org/
PyGantt	http://logilab.org/pygatt/
ScrumWiki	http://scrum.minty.org/