Spider-DAR: A Tool to Support the Implementation of Decision Analysis and Resolution Process based on CMMI-DEV and MR-MPS-SW Models

Luiz Otávio Danin de Lima, Sandro Ronaldo Bezerra Oliveira
Graduate Program in Computer Science
Federal University of Pará
Belém, Pará, Brazil
e-mail:otaviodanin@gmail.com, srbo@ufpa.br

Bleno Wilson Franklin Vale da Silva, Géssica Pinheiro da Silva, Iuri Igonez Silva Raiol
Faculty of Computing
Federal University of Pará
Belém, Pará, Brazil
e-mail:{blenofvale, gesspinhero, iuriraiol}@gmail.com

Abstract—**This paper presents a software tool called Spider-DAR, which is a desktop solution that operates in a client-server system and seeks to help the implementation of decision analysis and resolution process in adherence to CMMI-DEV (Capability Maturity Model Integration for Development) model. This involves the following: laying down the guidelines for decision analysis and the evaluation criteria, identifying alternative solutions, selecting evaluation methods, evaluating alternatives and selecting solutions. The software conforms to all the specific practices of the DAR (Decision Analysis and Resolution) process area included in CMMI-DEV. We expect that this tool will be readily adopted by software organizations because it is based on models and standards that are generally accepted. Furthermore, this tool adopts free (non-proprietary) technologies as a means of reducing costs. This tool was used in a software company that implemented its processes on the basis of CMMI-DEV Maturity Level 3, and the employees of this company evaluated its efficiency and effectiveness.**

Keywords-software engineering; software quality; decision analysis and resolution; process improvement; software tool.

I. INTRODUCTION

Within the domain of the knowledge and information society and the administrative scope of Information Systems (IS), there have been a number of significant changes in the social, technical and business domains. According to Evans *et al.* [1], the competition and cooperation that accompany the different stages of production have led to a growing trend: a desire to enhance it by automating the manual process and to make future improvements in a general way. Thus, in software engineering, as in several areas of knowledge, special skills are required to analyze different decisions made throughout the IS development and evolution process.

It is essential to analyze key issues, such as types of technology, the selection of personnel, and the acquisition of resources or tools, the value of which can be substantiated by means of a systematic process, so that rational choices can be made about what should be required from products or services. As defined in the Capability Maturity Model Integration for Development (CMMI-DEV) [2] the decision analysis establishes guidelines to determine which issues should be the objects of a formal evaluation process on the basis of defined criteria. This process involves adopting a structured approach to evaluate alternative solutions. Thus, the most appropriate choice about the real circumstances of a project or organization, significantly affects all the stages of its lifecycle. The decision-making processes and systems are of crucial importance to improve the efficiency, quality and cost / benefit ratio of the organizations.

Moreover, it is also worth underlining that the decision-making support is a new paradigm for organizations that seek to introduce continuous learning in all the processes carried out by its various sectors, because, according to Association for Promotion of Brazilian Software Excellence (SOFTEX) [3]:

- It facilitates the structuring of problems within a specific research study,
- It leads to an understanding of the information required to make effective decisions,
- It provides access to data, which would not otherwise be available or would be difficult to obtain,
- It generates and assesses alternative solutions,
- It prioritizes alternatives through explicit models,
- It prioritizes alternatives through a method that is supported by a formal and objective process and thus avoids making poor choices that are entirely based on subjective factors.

In this way, the Decision Management (GDE) process is included in the Brazilian Reference Model of Process Improvement for Software (MR-MPS-SW) [4] and the Decision Analysis and Resolution (DAR) process area is included in the CMMI-DEV [2] model. According to Pizzoleto [5], this makes it possible to generate indicators and form perspectives that can supplement and facilitate a better way of undertaking an activity; this involves setting these components within these improvement programs. Thus, this paper is driven by a desire to assist in defining and deploying a decision management strategy in organizations involved in software development. Moreover, it is guided by the essential activities and tasks, which are the expected results and specific practices included in the processes of these quality models that support the decision-making.

The area of decision-making for software development companies is very important, because today, most of these companies create spreadsheets to implement the practices included in the quality models. However, this does not allow the history of the company's decision-making to be

 ISBN: 978-1-61208-498-5

maintained and does not assist any formal evaluation of the problem that needs to be analyzed. For this reason, the development of a systematic tool, which centralizes the information obtained during the formal evaluation process, might benefit the future decision-making that is based on an analysis of the historical background; it might also guide the implementation of the decision management process in a systemic way.

Hence, the aim of this paper is to adopt an approach (workflow and tool) for the Decision Analysis and Resolution process area that is aligned with CMMI-DEV and MR-MPS-SW quality models. This approach is based on the specification and implementation of tools, which consist of: (1) a process workflow that takes account of the constant assets in quality models, and (2) a systemic support, with a free tool, to carry out activities defined in the workflow. On the basis of this approach, it is expected that it will be possible to simplify the implementation of the decision analysis and resolution process in organizations seeking the improvement, standardization and institutionalization of their development process, with an emphasis on the application of resources in software projects. This tool is based on free standards and technologies and is the outcome of research on the Software Process Improvement: Development and Research (SPIDER) project [6], carried out at the Federal University of Pará.

Following this introduction, Section II discusses the stages of the decision analysis and resolution stages in software process, and also reviews some related works in the literature. Section III outlines the approach adopted for the decision analysis and resolution, and the tool that supports its implementation. Section IV conducts an analysis of the application tool in industry and its adherence to the CMMI-DEV and MR-MPS-SW models. Section V examines the results obtained in this research study in both the academic world and industry. Finally, Section VI summarizes the conclusions.

II. Background and Related Works

This section provides an overview of the concepts of decision-making in the CMMI-DEV model and some related works.

A. Concepts and Definitions

A decision-making system is not just a sequence of instructions, but rather an organized team of people and set of procedures, software, information databases and devices used to support specific decisions that are made to tackle a problem. In a review of decision-making, Keeney [7] defines it in technical terms as reflecting different levels of a philosophy or methodology, that are articulated by a set of auxiliary axioms, that can be employed to address the complexity of the problems during the decision-making.

Decisions can be classified in terms of the time it takes to make them. They can be divided into two basic types: scheduled and unscheduled. Scheduled decisions are routine and repetitive, and the organization usually finds specific ways to deal with them. Unscheduled decisions are usually made once, which means they are generally less structured than the scheduled ones.

A model of the decision-making process that is recommended for management use includes the following: (1) identifying an existing problem, (2) listing possible alternative ways to solve the problem, (3) selecting the most promising alternatives and implementing the one that is chosen, (4) obtaining feedback to find out if the implemented alternative is able to solve the identified problem. However, this means that it is impossible for people who make decisions to know exactly what the future implications of implementing an alternative might be. This is because the dynamics of organizations and their environments are constantly changing and the future implications of the decisions that are implemented are not entirely predictable.

The quality models that guide this paper have equivalent processes that are the driving-force behind the review and support the decision management. Both models (CMMI-DEV and MR-MPS-SW) include specific practices and show the results of decision analysis and resolution. In a similar way, they employ objective criteria to explore, the resolutions of problems related to the decision-making, and these can be employed for the evaluation of alternative solutions, by means of a formal process. Table I shows the correspondence between the assets of both models (CMMI-DEV and MR-MPS-SW) with regard to their specific practices or expected results [4].

TABLE I. The Correspondence of Practices and Expected Results in the CMMI-DEV and MR-MPS-SW Models

Specific Practices of DAR process area - CMMI-DEV	**Expected Results of GDE process - MR-MPS.BR**
SP 1.1 Establish Guidelines for Decision Analysis	GDE1 - Organizational Guidelines to decisions management are established and maintained
-	GDE2 - The problem or issue is defined as the object of a formal process of decision-making
SP 1.2 Establish Evaluation Criteria	GDE3 - Criteria for the assessment of the alternative solutions are established and maintained in order of importance, so that the most important criteria exert more influence on the assessment
SP 1.3 Identifiy Alternative Solutions	GDE4 - Acceptable alternative solutions to the problem or issue are identified
SP 1.4 Select Evaluation Methods	GDE5 - The evaluation methods of the alternatives solutions are selected in accordance with their application viability
SP 1.5 Evaluate Alternative Solutions	GDE6 - Alternative solutions are evaluated by means of the criteria and established methods
SP 1.6 Select Solutions	GDE7 - Decisions are made on the basis of an evaluation of the alternatives based on the evaluation criteria that are laid down

 ISBN: 978-1-61208-498-5

B. Related Works

Assistance in defining a strategy and implementing a decision management in software development organizations is provided by the CMMI-DEV and MR-MPS-SW Implementation Guides where activities and key tasks are described, together with the expected results and specific practices that are included in the process to support decision-making. However, despite the availability of these guides, most organizations that attempt to deploy an analytical decision-making process experience obstacles, which prevent or delay their implementation. Among the main difficulties that have been encountered periodically, is the problem of defining a non-intrusive strategy, i.e. ensuring that it does not have an impact on people's daily activities in the organizational unit and can easily be integrated with other processes. As well as this, there is the question of choosing appropriate tools to support and facilitate the use of the practices required by a Decision Management process. Thus, the choice of tools to be adopted can be regarded as a crucial factor in employing a defined strategy that can implement the decision support in organizations.

Thus, the choice of free software tools is justified by the economic self-sufficiency and freedom that a certain product in this category can give. According to Campos [8] one of the freedoms provided is that it improves the software so that it can be used in either a personal or public way in organizations. However, on the basis of research carried out in the specialized literature, no free and completed tools were found that support and facilitate the decision management, and have an adherence to the MR-MPS-SW and the CMMI-DEV models. The tools and models researched do not have the characteristics mentioned, although they were of significance in the area of decision management, (whether academic or marketing). These tools are discussed below.

The DPMTool [9] supports decision management in software projects, in the domain of global development. Thus, the description of this tool states that it allows the creation, storage, recovery and transmission of decisions made by a software design, and performed in a distributed way. In addition, the tool allows the project managers to control the information about software projects, since the value and importance of project development is that it also provides techniques that can allow the decision-making carried out in previous projects to be re-used for new projects, which have similar features.

The main purpose of this tool is that it allows information from previous decisions to be used again; to support the decision-making in future projects. However, there is no evidence that this information is, in fact, useful. In addition, the management of roles or the way criteria is laid down is not clear in the DPMTool, or even if there is a systematic process involved. Hence, the reuse of knowledge for project management is something that is not trivial, and it is being used by distributed teams in an even more challenging way. However, understanding and carrying out project management, in an efficient way, has become the greatest challenge for distributed teams.

It is known that the information sharing is restricted to certain professionals (e.g. managers). Likewise, in this kind of work, i.e. in a single project that is undertaken by many professionals (managers) spread around the globe, only a few of them will obtain crucial information for the correct decision-making, and most of those who take part in projects, will not necessarily know all the solutions adopted by the other participants in the same project. In addition, from the standpoint of decision-making, this kind of work does not seems to be as productive, as a continuous process in which the team reaches an agreement, about what criteria should be employed and the alternative solutions that can be found.

Another study on simulation models [10] describes the results of a project, which aimed at investigating specific aspects of decision-making in personnel management, which involved software projects and development teams and took account of dynamic variables, such as stress, conflicts, motivation and performance. The simulation was adopted that employs system dynamics models as a powerful technique to deal with the problem. In this study, decision-making is regarded as a means of giving support to personnel management through an evaluation model applied to other useful projects. However, it includes features that allow a high degree of subjectivity in personnel management. Moreover, the project can even be influenced by other variables that are not taken into account - for instance, the variable about motivation is not included in the survey. In the decision management processes governed by the CMMI-DEV and MR-MPS-SW models, it seeks to reduce subjectivity to a minimum in the process so that the decision-making is not biased.

From the works reviewed, it is clear that the authors were not concerned about implementing decision management in a systematic way. They did not adopt the traditional practices set out in the quality models that guide the implementation of a decision-making process. Moreover, they have failed to design support tools that could adopt all the concepts and fundamental principles of a formal evaluation. It was also noted that the works did not apply the evaluations obtained from their approaches to the academic world or industry; nor did they provide an analysis of the efficiency and effectiveness of the solutions that support decision-making.

III. A TOOL THAT SUPPORTS DECISION ANALYSIS AND RESOLUTION

The support concept adopted in this paper defines a set of technologies that can be integrated to assist in the decision analysis and resolution process. This domain includes the following: tools, techniques, procedures, processes, roles, methodologies, frameworks, languages, standards, patterns, and so on.

A. The Spider-DAR Workflow

The aim of this section is to describe the Spider-DAR workflow for the Decision Analysis and Resolution process. The workflow can be split into seven tasks that cover all the

 ISBN: 978-1-61208-498-5

requirements and expected results from MR-MPS-SW [4] and specific practices from CMMI-DEV [2]. Fig. 1 illustrates the process workflow.

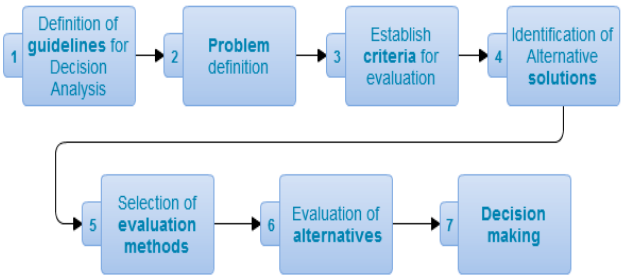

Figure 1. A Flowchart for Decision Analysis and Resolution

The first task consists of defining the guidelines for the decision analysis process, and basically involves setting out institutional guidelines for formally selecting the problem to be solved. According to Table I, this task involves DAR SP 1.1 in CMMI-DEV and GDE1 in MR-MPS-SW.

Following this, the second task of the main process is the formal definition of the problem or issue to be solved, which can enable an objective analysis of the problem to be conducted. This task is required for the GDE2 in MR-MPS-SW.

After the two tasks have been carried out, the next one takes place after the problem definition. It consists of the definition and prioritization of all the listed criteria for the problem, so that they can be evaluated later. The SP 1.2 in CMMI-DEV and the GDE3 in MR-MPS-SW are attained on completion of the third task.

The fourth task is carried out after all the possible criteria needed to evaluate the problem have been defined and involves examining all the possible alternative means of solving it. Furthermore, this task requires discussing all the possible alternatives and, additionally, it is necessary to assess the risks associated with the alternative solutions for future evaluations. Thus, this task covers the SP 1.3 in CMMI-DEV and the GDE4 in MR-MPS-SW.

With the aid of both the criteria and alternative solutions, the next task is to define the methods for evaluating the alternative solutions, and select which method is more appropriate for evaluating each alternative. This task covers the SP 1.4 in CMMI-DEV and the GDE5 in MR-MPS-SW.

The alternative evaluation process is the core of the DAR process. The aim of this task is to make an evaluation of all the alternative solutions by using all the defined criteria in the process; the selected method is then employed to rank the best solutions to the problem. This phase involves analysis, discussion and a review. Thus, the SP 1.5 in CMMI-DEV and the GDE6 in MR-MPS-SW are covered in this process.

The final task involves choosing the most appropriate solution for the problem or issue being analysed, and hence, registering and documenting all the experiences for future usage. This task covers the SP.1.6 in CMMI-DEV and the GDE7 in MR-MPS-SW.

B. *The Spider-DAR Tool*

The Spider-DAR is a General Public License (GPL) tool that is specifically concerned with Decision Management, and adhering to the good practices recommended by the CMMI-DEV and the MR-MPS-SW models. The requirements that guided the development of the tool were extracted from the workflow presented in this paper.

This tool was developed as a desktop environment using Java and was based on the use of free technologies, such as Netbeans 8.0.2 IDE, MySQL 6.3 DBMS and the iText, a library for creating and manipulating PDF files.

The architecture of Spider-DAR was based in the three-layer model called Model-View-Controller (MVC). Thus, the actions that occurred are managed by controllers, which make the intermediation between the interface with the user and the entities modeled in the database. The main benefit of its use is its ease of maintenance and the fact that any new components that might arise can be added, like a change of interfaces or the native database.

The development team had a standardized method to facilitate the encoding system, as well as to optimize computing resources. The FACADE and SINGLETON [11] design patterns were also used for uncoupling the business layer from the persistence layer and thus, providing a better management of the instantiated objects. The architecture is visualized in Fig. 2.

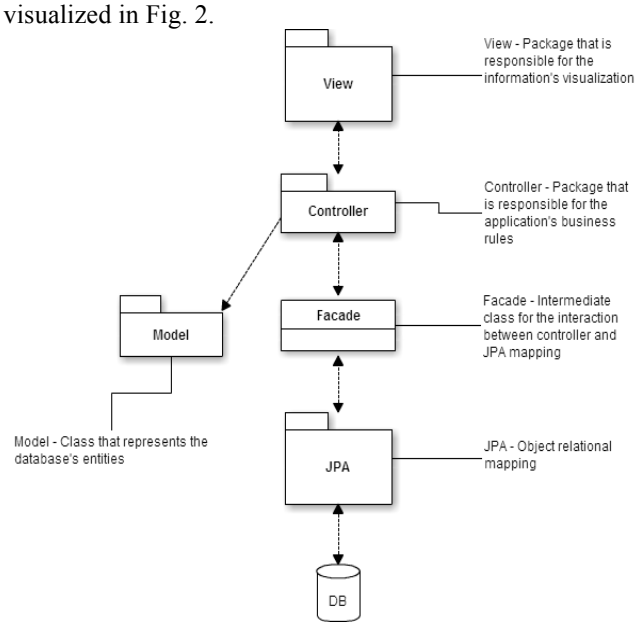

Figure 2. The Architectural Components of Spider-DAR

The Spider-DAR tool was designed for use in organizations and academic environments, to support multiusers. Each unit of the organization has an area in the tool to register and evaluate problems. The tool allows the storage of a Decision Management Guide in a text format, and also attaches an existing document, for future searches. The Decision Management Guide is used to define how a process should be implemented within the organization. The centralization of information streamlines the planning and

 ISBN: 978-1-61208-498-5

monitoring, and reduces the effort required for the execution of the project.

The tool allows the registering of problems that will be objects of the decision-making process, and also the allocation of participants for its execution. Each participant has a profile that determines which modules of the tool the participant has access to. Fig. 3 shows the details of the problems to be registered.

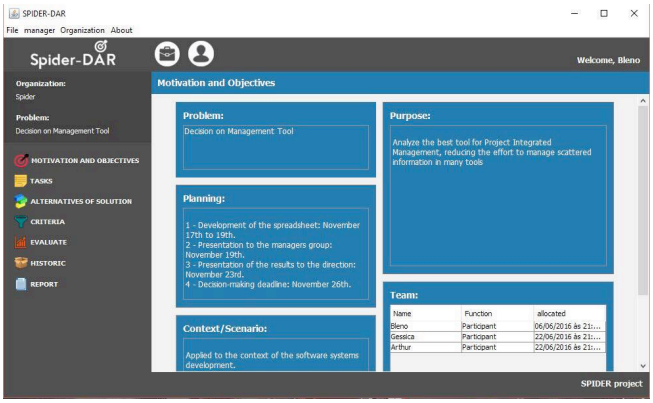

Figure 3. Motivation and objectives of a problem registered in spider-DAR

After the problem has been defined, it is permissible to define alternative solutions and the features that will be applied to evaluate the viability of these alternatives. The tool also allows the evaluation criteria in each problem, to be defined; these are variables that will influence the choice of alternative solutions.

The Spider-DAR has a module to evaluate the alternatives, as shown in the Fig. 4. The rate of satisfaction is calculated in accordance with the established criteria and, a ranking is generated in a visual way to determine which alternative is the best for the resolution of the problem. The tool just indicates which alternative is more viable, however, and because of the peculiarities of each problem, the decision-making is the responsibility of the user.

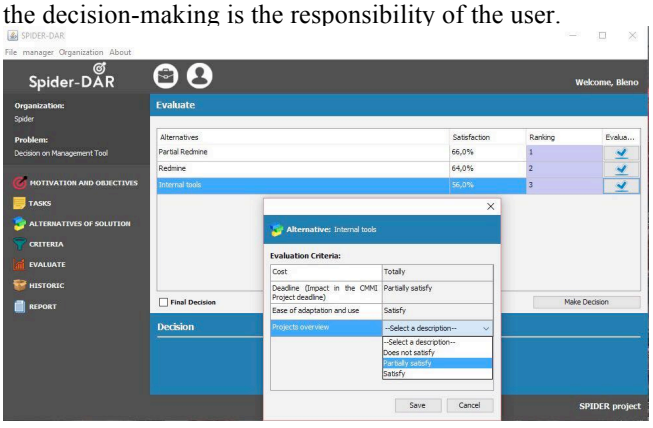

Figure 4. Evaluation of alternatives solutions in Spider-DAR tool

During the management process or after it has been completed, the tool can at any moment allow, the user to generate a report in a PDF file with all the entries of the data tools. Thus, after the end of the decision management process, a generated report will contain the data of the Problem, Alternatives Solutions, Evaluation Criteria, Evaluation and Decision, and this will facilitate the analysis of the whole process until the result has been obtained.

IV. Software Tool Evaluation

This section describes the tool evaluation in the software industry and their adherence to CMMI-DEV.

A. Application in the Software Industry

The tool was used during the implementation of CMMI-DEV Maturity Level 3 in a software development organization in Brazil, called EMPREL, in 2015 and 2016, and supports constant practices in the Decision Analysis and Resolution (DAR) process area. The organization was assessed at this level and obtained a certificate issued by the CMMI Institute.

The tool's users reported that its use made it possible for the organization to carry out a historic decision-making in all the software development projects. It also undertook a mapping of the problems and decision-making to facilitate the knowledge management, and thus provide a more efficient and effective means of managing the implementation of the DAR process area.

The EMPREL employees evaluated the Spider-DAR tool as efficient and effective to support for decision management. The main obtained results were:

- The use of the tool allows a decentralization of employees responsibilities during the execution of tool features, because all employees can perform together the formal evaluation process,
- Because the workflow implemented in the tool presents sequenced activities and tasks, this tool allows a systematic implementation of the Decision Analysis and Resolution process,
- The continuous maintenance of the historical basis in the tool allows the analysis of information generated from a problem or issue resolution during the decision-making of another problem or issue;
- By execution of features the tool facilitates the structuring of problems or issues, leads to an understanding of the information required to make effective decisions, generates and assesses solutions and prioritizes alternatives through a method that is supported by a formal and objective process.

The official CMMI assessment confirmed that the use of the tool had been successful. It should be emphasized that this company was chosen because it meant that the authors of this paper were able to conduct the implementation of the organizational process improvement program in its organizational units.

B. Adherence to CMMI-DEV

The Adherence concept analysis of the proposed tool is conducted through the mapping of the features outlined in Section III with the specific practices (SP) contained in the DAR process area in CMMI-DEV and the expected results (ER) in the GDE process included in MR-MPS-SW. Specific practice can be defined as "the description of an

activity that is considered important in achieving the associated specific goal, i.e. it describes the activities that are expected to result in the achievement of the specific goals of the CMMI process area" [2] and expected results is "an observable result anticipated from the successful performance of the process" [12]. The description of the specific practices and the expected results were shown in Table I. This analysis can be observed in Table II.

TABLE II. ADHERENCE BETWEEN THE SPIDER-DAR FEATURES TO CMMI-DEV AND MR-MPS-SW

SP	ER	RequiredTasks	Tool Features
SP1.1	GDE1	• Set out a formal decision guide, • Evaluate the questions of high to medium impact risk for the organization.	Definition of Guidelines for Decision Analysis
-	GDE2	• Definition of the problem or issue which will be the object of a formal decision-making process, • Definition of the scope of the problem or issue.	Problem Definition
SP1.2	GDE3	• Define the criteria for the evaluation of alternative solutions, • Define the range and scale for ranking the evaluation criteria, • Rank the evaluation criteria.	Establish the Criteria for Evaluation
SP1.3	GDE4	• Identify alternative solutions.	Identification of Alternative Solutions
SP1.4	GDE5	• Select evaluation methods based on their ability to focus on the issues and problems that are not being influenced by them, • Determine the measures needed to support the evaluation method.	Selection of Evaluation Methods
SP1.5	GDE6	• Evaluate alternative solutions proposed using the evaluation criteria established and the methods selected, • Obtain and record the results of the evaluation.	Evaluation of Alternatives
SP1.6	GDE7	• Recommended solutions to address significant issues, • Register and communicate the results and rationale for the recommended solution to the appropriate stakeholders.	Decision-making

To view the details of each of the recommendations of the specific practices and expected results listed in the first and second columns of Table II, it is necessary to consult the official guides of the CMMI-DEV [2] and MR-MPS-SW [4].

V. OBTAINED RESULTS

This section describes the results of this work that were obtained for the academic world and industry.

A. The Academic World

This research study included two graduate students and two undergraduates who are studying this subject and monitoring process improvement in a software development organization as research assistants. The research can be characterized as a subproject of the SPIDER Project, and was accepted for the 2011/2012 cycle of the PBQP-SW (Brazilian Program of Software Quality and Productivity). The Workflow and the Tool were the subject of a master's dissertation that was defended at the Federal University of Pará (Graduate Program in Computer Science). Thus, a workflow process and a tool to support the decision management were obtained, and an investigation was conducted to verify how these results (described in Section IV) could be implemented in a software company.

In academic world, the tool presented in this paper can help with the teaching of decision analysis and resolution because it has a systematic step by step of the activities that compose this knowledge area. This tool can also be used to simulate the learning of implementation of process improvement program through the use of concepts of decision analysis and resolution. Students involved in this work have been trained in the area of decision analysis and resolution through this tool and today they help the software companies in the implementation of good practices included in this area and in the quality models.

B. In Industry

The authors used the technology described in this paper for consultation projects related to process improvement. First, the tool was used by software development organizations that are partners of the SPIDER project, such as the EMPREL, which is located in Recife city. Basically, the tool assisted in the different stages of the decision analysis and resolution by defining and monitoring the projects. On the other hand, the activities of the Workflow are widely adopted in the implementation of Maturity Level 3 of CMMI-DEV in organizations in which the authors act as consultants, located at Porto Digital (Recife city) and Farol Digital (João Pessoa city).

The tool helped efficiently and effectively the Emprel reach the CMMI-DEV Maturity Level 3 because it has a workflow that meets all specific practices included in the decision analysis and resolution process area. Thus, the strenghts for the Emprel employees were:

- The employees perform a formal evaluation of the problems or issues through the tool's features, performing together this evaluation because they do not work with spreadsheets that were under the control of a single person. Thus, the employees feel part of decision-making,
- Through the information maintained in the tool database and used to obtain the results in previous decisions, the employees can identify insights that can help in current decisions. It can help in the knowledge management,
- The employees know which information should be filled to the implementation of a formal evaluation

 ISBN: 978-1-61208-498-5

because the tool displays all the fields required for this one. Thus, the decision process becomes less complex,

- The final decisions of the employees are founded on a formal method that prioritizes the alternatives according to the evaluation criteria. Thus, it makes the evaluation more formal and objective.

VI. CONCLUSION

The development of the decision analysis and resolution tool is intended to support the activities about decision analysis and resolution in software process which are based on the good practices defined by the quality models and standards. Hence, the Spider-DAR systemic approach is designed to facilitate the adoption of these models and standards by the software development organizations that use this tool.

In the face of many possible systemic and business solutions, our approach addresses the challenge of becoming a solution that can be employed in multiple scenaries. It is not linked to commercial interests, and is a viable candidate for consideration when compared with the private solutions that are marketed.

Of the lessons learned from this project, we would like to list the following: the importance of systematic processes for the implementation of a decision-making process, and the development of a support tool for this process. The main challenge of this work was to implement the results in a software company that is keen to adopt good practices within a quality model.

It should be noted, as a strong point of this research project, that the tool is opensource, and can thus enable the academic community and / or industry to contribute to the development and evolution of this solution. The use of the tool is also of value since it helps the software organization to achieve more satisfactory levels of discipline through the combination of techniques and methods that assist in the decision analysis and resolution of its processes.

As a future study, that is already in development, we are seeking to integrate this tool with other tools available in the SPIDER project by focusing on a joint venture which involves the implementation of the other process areas included in CMMI-DEV and MR-MPS-SW, such as risk management, project planning, configuration management, and product and process quality assurance.

ACKNOWLEDGMENTS

The authors would like to thank Coordination for the Improvement of Higher Education Personnel (CAPES) for granting a Master's degree scholarship to the Postgraduate Program in Computer Science at the Federal University of Pará (PPGCC/UFPA). We are also grateful to the Institutional Scientific Initiation Scholarship Program (PIBIC-UFPA) for granting a scientific initiation scholarship. Both programs are sponsored by the Brazilian Government. The authors would also like to thank the Dean of Research and Postgraduate Studies at the Federal University of Pará (PROPESP/UFPA) for providing financial support through the Qualified Publication Support Program (PAPQ). This subproject is part of the SPIDER Project (*www.spider.ufpa.br*), institutionalized at the Federal University of Pará.

REFERENCES

[1] D. S. Evans, A. Hagiu, and R. Schmalensee, 2006, "Invisible Engines: How Software Platforms Drive Innovation and Transform Industries", Cambridge, MA: The MIT Press, 2006.

[2] SEI – Software Engineering Institute, "CMMI for Development – V 1.3", 2010, Available: http://www.sei.cmu.edu/reports/10tr033.pdf. Retrieved: march, 2016.

[3] SOFTEX – Associação para Promoção da Excelência do Software Brasileiro "Implementation guide Level C of MR-MPS-SW", 2015, Available: www.softex.br/mpsbr.Retrieved: march, 2016.

[4] SOFTEX – Associação para Promoção da Excelência do Software Brasileiro, "General Guide of MPS Software: 2012", 2012, Available: http://www.softex.br/mpsbr.Retrieved: march, 2016.

[5] A. V. Pizzoleto, "Business Ontology of the reference Model Mps for software (Mr-Mps-Sw) with focus on G E FLevels", Dissertação de Mestrado, São José do Rio Preto - Universidade Estadual Paulista, 2013.

[6] S. Oliveira, M. Souza, W. Lira, E. Yoshidome, and J. Furtado, "A System Solution Proposal of a Free Software Tools SUITE to Support the Implementation of MPS.BR Model", Revista do Programa Brasileiro de Qualidade e Produtividade em Software, pp. 103-107, 2011.

[7] R. L. Keeney, "Decision Analysis: An Overview", Operations Research, Vol. 30, N. 5, 1982, pp. 803-838.

[8] A. Campos, "What is Free Software", BR-LINUX, 2006, Available: http://br-linux.org/linux/faq-softwarelivre. Retrieved: april, 2016.

[9] P. J. Garrido, A. Vizcaino, J. Andrada, M. J. Monasor, and M. Piattini, "DPMTool: a tool for decisions management in distributed software projects", in: Proceedings in the 7th International Conference on Global Software Engineering, ICGSE, Workshops, Porto Alegre, Brazil, 27–30, 2012.

[10] S. D. Costa, J. L. Braga, L. A. Abrantes, and B. G. Ambrósio, "Suppport in decision making in people management software process based on simulation models", RESI: Revista Eletrônica de Sistemas de Informação, v. 12, p. 1-27, 2013.

[11] E. Gamma, R. Helm, R. Johnson, and J. Vlissides, "Design Patterns: Elements of Reusable Object-Oriented Software", Bookman, 2010.

[12] ISO/IEC – the International Organization for Standardization / International ElectrotechnicalComission, "ISO/IEC 15504-1: Information Technology - Process Assessment - Part 1: Concepts and Vocabulary", Geneve, 2004.

 ISBN: 978-1-61208-498-5