

Lessons Learned and Software Process Improvement

Sussy Bayona Oré

Dirección de Investigación, Universidad Autónoma del
Perú, Lima, Perú
luz.bayona@autonoma.pe,
sbayona@hotmail.com

Tomas San Feliu

Facultad de Informática, Universidad Politécnica de
Madrid, Madrid, España
tomas.sanfeliu@upm.es

ABSTRACT

Current methods focus on the aspects related to the lessons learned, feedback and information sharing, however many organizations do not establish feedback mechanisms for organizational learning with the lessons learned as a result of process deployment initiatives participation. This paper describes the steps in order to identify the lessons learned as a result to put in practice the processes. It also provides a practical analysis of lessons learned identified in software process deployment initiatives in order to improve the knowledge in the organizations.

CCS Concepts

•Software and its engineering→Software development process management

Keywords

process deployment, lessons learned, CMM, process asset library

1. INTRODUCTION

The organizations use different reference models or standards such as CMMI [1] or ISO 15504 [2] and define their processes to be used in software products development. The defined processes are stored in the organization's process asset library and deployed across the organization using a formal method [3]. Process deployment is about getting the processes into practice and its success strongly depends on people on all levels: individual, group or organizational.

For that reason, the method used to deploy the processes should incorporate both technical aspects and issues related to people [4]. However, the problem arises when organizations do not manage the change or neglect social aspects. The method to deploy processes must consider issues related to training, communication [5], staff involvement, roles and responsibilities, change management, commitment, and shared knowledge such as lesson learned, and all of them are related to people.

Studies conducted in multinational organizations show that set of strategies related to learning influences the success of process improvement initiatives [6]. A lesson learned is the knowledge gained from experience as a result of staff participation in software process deployment or software projects initiatives. A lesson learned is a critical factor in ensuring a successful process improvement program [7]. For that reason, the results and lessons

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learned should be monitored.

A significant challenge for software organizations is to ensure that lessons are learned and that mistakes of the past are not repeated. Aspects of health care, nuclear power, rail, and aviation organizations have successfully implemented organizational learning, however, there are limited practical methods to use and conceptualize what organizational learning is and how to enable it. In consequence, organizations are failing to learn from their past project experiences [8]. People involved in a process deployment initiative learn from past projects experiences, gain new skills, knowledge, experience and learn lessons. Documenting the lessons learned helps transforming the knowledge that resides in people (implicit knowledge) into explicit knowledge in order to be disseminated through the organization and shared among organization's members. However, when the organization does not have mechanisms to document and incorporate the lessons learned in organizational practice, the mistakes are repeated and the processes are not improved.

This paper aims at showing the results of the application of MEDEPRO method [9]. MEDEPRO has been designed to implement processes defined by the organization focus on people. MEDEPRO has five phases. In this paper we focus on Phase 5 called "Feedback". At this stage there is a proposal to incorporate lessons learned to process asset library and it is a guide for practitioners involved in process deployment.

The rest of this paper is structured as follows: Section 2 describes the research work context. Section 3 the proposed MEDEPRO method to incorporate the lessons learned to process asset library, while Section 4 presents the lessons learned in software process deployment initiatives. Finally, we present conclusion and future work in Section 5.

2. RESEARCH WORD CONTEXT

Two concepts are important to define tacit and explicit knowledge. Chao [10] defines tacit knowledge as the personal knowledge used by members to perform their work and to make sense of their worlds. Sullivan [11] define explicit knowledge as any piece of knowledge that becomes defined, usually by being written down or entered into a computer, qualifies as an intellectual asset and can be protected. At the end of process improvement implementation, the staff has a lot of experience and knowledge, but sometimes this tacit knowledge is not shared. It resides in the people as a lesson learned.

According to McIntyre [12] lessons learned refer to the act of learning from experience to enhance institutional learning, improve organizational performance and achieve success. The lessons learned are generally two types: (1) positive when they were positive for the project and should be replicated in future similar projects, and (2) negative when they were experiences that should not be repeated. Sometimes the staff has little time and motivation to carefully reflect on their past experiences and to diligently document the lessons they learned to reuse in the future [13].

Culture also plays an important role in knowledge sharing. Diverse studies point that people factors influence the success of the lessons learned process and that a learning organization culture is critical to successful dissemination of lessons learned [14] [15]. The accumulated knowledge and valuable lessons learned throughout the project, if not effectively shared with other projects, can be regretfully lost [16].

Feedback is an attribute of learning organizational. The staff requires feedback in order to insure practice is productive and builds confidence. So, transfer knowledge requires that it be accessible to as needed and for that tacit knowledge may be shared. The categories used by authors to classify the factors are related to people, product, overall satisfaction and share information (see Table 1).

Table 1 Categories used to classify the lesson learned

N	Category	Description
1	People	Related to knowledge that people acquire in the course of their duties and activities and the ability to communicate and share this knowledge [17], [18].
2	Product	Related to lessons learned as a result of a set of activities and tasks of software process deployment, and their incorporation to the assets of the organization [19].
3	Overall satisfaction	Overall satisfaction. Related to motivation to collect and share the best of the organization, first at the organization level, and after sharing with the outside [17].
4	Share information	Share information. Related to sharing the positive and negative lesson learned in order to improve the process and can be used in future projects [21].

Some factors related to feedback and lesson learned identified as a result of literature review are: knowledge sharing [6], learning organizational [6], learning from the feedback results [17], knowledge of people in related work [18], feedback [19], lesson learned [20], shared best practices [21], collecting company best [22], external consulting support and knowledge transfer [20], information sharing [23], create teams and share information [24]. Some barriers to knowledge sharing are presented in Table 2.

Table 2 Barriers to knowledge sharing

N	Category	Description
1	Individual	Lack of time to share knowledge [25, 26, 27]
		Lack of awareness about the shared knowledge benefits, not perceived usefulness [25, 26, 27]
		Lack of job security due to fears that risks the exchange could cause [25, 27, 28]
2	Organizational	Lack of leadership [25, 26]
		lack of motivation or reward [13, 25, 26, 28]
		Lack of organizational culture [14,15, 25, 26, 27, 28]
		Staff turnover [29]
		Lack of resources [25, 27]
3	Technology	Lack of integration of systems and processes [25,27]
		Information overload and redundancy [28]

So, sharing knowledge and lessons learned are the basis of a software process deployment initiative.

2.1 CMMI and Lesson Learned

CMMI is a set of best practices for the development, acquisition and maintenance of products or services. CMMI DEV is a model which provides for best practice organizational process improvement where process improvement proposals and process lessons learned are said to be key work products and sub-processes. This model defines five maturity levels and it includes 22 process areas. According to CMMI the candidate improvements to the organization's processes are obtained through various sources including lessons learned.

The process area Process Focus Organization (OPF) makes reference to specific practices related to the process deployment and lessons learned. Moreover, lessons learned are an essential aspect of the Generic Goal 3 (GG 3) "Institutionalize a defined process," Generic Practice 3.2 "Collect process related experiences."

In Specific Practice 3 "Document lessons learned from the process for inclusion in the organization's process asset library" same examples are mentioned: (1) Submission of lessons learned to the organization's process asset library (OPD), Lessons learned captured from analysis of process performance data compared to business objectives (OPM), Lessons learned from the requirements allocation process (RD) and Lessons learned in resolving ambiguous requirements (RQM).

In several process areas of CMMI we can find practices related to lessons learned. Table 3 shows a summary of the process areas and sub practices related to lessons learned. As seen in Table 3, the lessons learned are present in most process areas, but these are scattered and disjointed. Although the CMMI considered practices to maintain the organizational process assets updated with lessons learned, an improper model implementation makes this activity irrelevant.

But whilst there are many models and methods to choose from, much of the literature re-enforces the point that people factors influence the success of the lessons learned process and that a learning organization culture is critical to successful dissemination of lessons learned [8].

This paper presents a proposal to manage the lesson learned as a result of the process deployment. We can summarize that a lesson learned:

- Can be taken into account to give alternative solutions in similar decisions.
- It is an artefact of the process asset library and contributes with it.
- It is a product of the improvements pilots and the deployment process.
- Allows to identify opportunities for improvement and training needs.
- It is a result of evaluating objectively the processes, products and services.

3. MEDEPRO AND LESSONS LEARNED

Process Deployment Method (MEDEPRO) is a method that promotes effective and efficient use of deployed processes throughout the organization, incorporating infrastructure, training, communication, change management, adoption and motivation activities to use the processes, lessons learned, and metrics factors

to evaluate the deployment process. MEDEPRO means process deployment focus in people and change management [9]. The process deployment method has five stages:

- **Establish the infrastructure:** the purpose is to establish a process deployment team, secure the resources necessary to carry out the activities, and obtain the commitment at high levels of the organization.
- **Motivate the processes use and adoption:** the purpose is to establish the process deployment plan that integrates communication, training, change management plan, metrics plan and planning.
- **Manage deployment:** the purpose is to deploy the processes using the process deployment plan.
- **Monitor deployment:** the purpose is to monitor and control effective process deployment using the proposed metrics.
- **Feedback:** the purpose is to identify, document the lessons learned that could improve processes for future products and services and to be included in the PAL.

This paper focuses on the fifth stage called "Feedback". The purpose of this stage is to define the process to be used for the organization in order to identify, collect, select and store and disseminate the lessons learned.

Furthermore, improve the processes as appropriate. The deployment workgroup is responsible for the activities of this stage. Figure 1 shows the stages and activities involved in Phase 5 MEDEPRO. Next, a description of each stage.

3.1 Stage 1. Identify and Collect the Lessons Learned

The purpose is to identify the lessons learned by the staff involved in the process deployment. Here are the steps to follow.

- **Identify the lessons learned.** It evaluates the process deployment with the stakeholder's participation. They are asked for their feedback on the deployment process. Sources to identify lessons learned include: individuals, teams, projects or business unit.
- **Collect the lessons learned.** The survey forms filled are collected. Questionnaires are sorted by topic and grouping by items related. A review to identify duplicity and consolidate the cases.

3.2 Stage 2. Select the Lessons Learned

The purpose is to define the selection criteria to select the lessons learned that will be incorporated into the process asset library. Next the steps to follow.

- **Define the selection criteria.** It should establish criteria such as applicability, validity indicating the basis of actual practice, indicating significant defect reduction and the failure probability, easily comprehensible, understanding and avoiding duplication of proposals.
- **Select the lessons learned.** The lessons identified are reviewed using the selection criteria.
- **Verify the lessons learned.** The lessons learned selected are verified taking into account that each lesson has information relevant approved.

3.3 Stage 3. Get Feedback on the Processes Use

The purpose is that the lessons learned from selected processes are identified using the measures in order to analyse and evaluate the results and improve the processes. Next the steps to follow.

- **Measure the processes use** taking into account the metrics defined in the process deployment plan. The metrics are: use, acceptance level and process complexity.
- **Analyse and evaluate the results.** It may seek the causes of deficiencies by the answers to the following questions. Why some processes are not used? Have been ill defined? Why processes are rejected? Why do processes need to be modified? Why processes are complex for users? Did they have adequate training?

3.4 Stage 4. Incorporate the Lessons Learned

The purpose is to filter and validate the lessons learned. From the analysis we can discard the lessons that have been detected as duplicate, which do not meet the selection criteria or that are embedded in other processes. The lessons that have been selected are validated using information from the results of the status of the processes and then incorporate at process asset library.

3.5 Stage 5. Report Results

The purpose is to prepare a report with the results and define the proposed corrective measures where necessary. The results and the reasons should be communicated to staff, using the media in the organization (written and verbal). They can also be disseminated through training programs, review of processes and review of plans.

4. CASE STUDY

This section presents the results of the application of the lessons learned feedback. In this case, the lessons learned are the result of learning gained by those responsible that led process deployment initiatives in five software organizations. For this purpose, the activities included in Stage 5 "Feedback" of MEDEPRO, were put in practice. In this paper we show the practical experience of process deployment initiatives which were conducted by experimented staff of five organizations involved in software development.

We present selected lessons learned and results achieved in the deployment process.

- **Lesson 1: Staff Involvement** is considered as a critical factor by different authors according to literature review. The staff participation in processes minimizes resistance to change. It was considered as positive.
- **Lesson 2: Process definition** must be generic, flexible, practical, measurable, auditable, and appropriate to the organization's needs, so it is necessary to have guidelines for tailoring the standard process. It was considered as positive.
- **Lesson 3: Top level commitment** is the most important factor in order to count with the resources and the infrastructure. Also determine which policies must be established and assign the priorities. It was considered as positive.
- **Lesson 4 Communication** is an important factor to maintain an adequate, effective and bidirectional communication. Also an efficient communication strategy can reduce employee resistance to change. It was considered as positive.
- **Lesson 5 Assign roles and responsibilities** according to staff knowledge and abilities. They must be defined and do not overload the activities. They must know: What to do, How to

do, and When to do. Assigning more than one role to the same person was considered negative.

- **Lesson 6:** Establish a training plan for the new processes. Self-education requires personal motivation is a prerequisite for learning and requires an exercise of control by the learner.
- **Lesson 7:** Implementing a new process is a change which must be managed to avoid people resistance, so it is necessary to

manage the change. Moreover, it is necessary to assess and measure the scope of processes change.

- **Lesson 8:** Process deployment monitoring in order to evaluate their process use and that the processes are adequate to needs organization. It will allow to take the corrective actions and correct mistakes.

Table 3 Other process area CMMI and the lessons learned

N	Area	SG	SP	Specific Practices
1	DAR	SG1	SP 1.3	1.Perform a literature search: A literature search can uncover what others have done both inside and outside the organization. It may provide a deeper understanding of the problem, alternatives to consider, barriers to implementation, existing trade studies, and lessons learned from similar decisions.
2	IPM	SG1	SP 1.1	SP 1.1 Establish the Project's Defined Process 4. Use other artifacts from the organization's process asset library as appropriate.
3			SP 1.5	SP 1.5 Manage the Project Using Integrated Plans 1. Implement the project's defined process using the organization's process asset library. This task typically includes using lessons learned from the organization's process asset library to manage the project
4			SP 1.7	SP 1.7 Contribute to Organizational Process Assets 4.Document lessons learned from the project for inclusion in the organization's process asset library.
5	OPD	SG1	SP 1.5	SP 1.5 Establish the Organization's Process Asset Library Examples of items to be stored in the organization's process asset library include the lessons learned reports
6	OPF	SG1	SP 1.3	1. Determine candidate process improvements. Candidate process improvements are typically determined by doing the following: (1) Review the lessons learned from tailoring the organization's set of standard processes and (2) Review the lessons learned from implementing the processes.
7		SG3	SP 3.4.	SP 3.4 Incorporate Experiences into Organizational Process Assets 2. Obtain feedback about the use of organizational process assets. 3. Derive lessons learned from defining, piloting, implementing, and deploying organizational process assets. 4. Make lessons learned available to people in the organization as appropriate.
8	OPM	SG2	SP 2.3	SP 2.3 Validate Improvements 7. Review and document the results of validation. Identifying and documenting lessons learned and problems encountered during the pilot including feedback to the improvement team and changes to the improvement.
9		SG3	SP 3.2	SP 3.2 Manage the Deployment 8. Document and review results of improvement deployment. Documenting and reviewing results includes the following: Identifying and documenting lessons learned Revising improvement measures, objectives, priorities, and deployment plans
10	PMC		SP 2.3	SP 2.3 Manage Corrective Actions 3.Determine and document appropriate actions to correct deviations from planned results from performing corrective actions. Lessons learned as a result of taking corrective action can be inputs to planning and risk management processes.
11	PPQA	SG1	SP 1.1	SP 1.1 Objectively Evaluate Processes 5. Identify lessons learned that could improve processes.
12			SP 1.2	SP 1.2 Objectively Evaluate Work Products 6. Identify lessons learned that could improve processes.
13	RSK		SP 2.1	SP 2.1 Identify Risks Identify and document risks. Many methods are used for identifying risks on of them is examine lessons learned documents or databases.

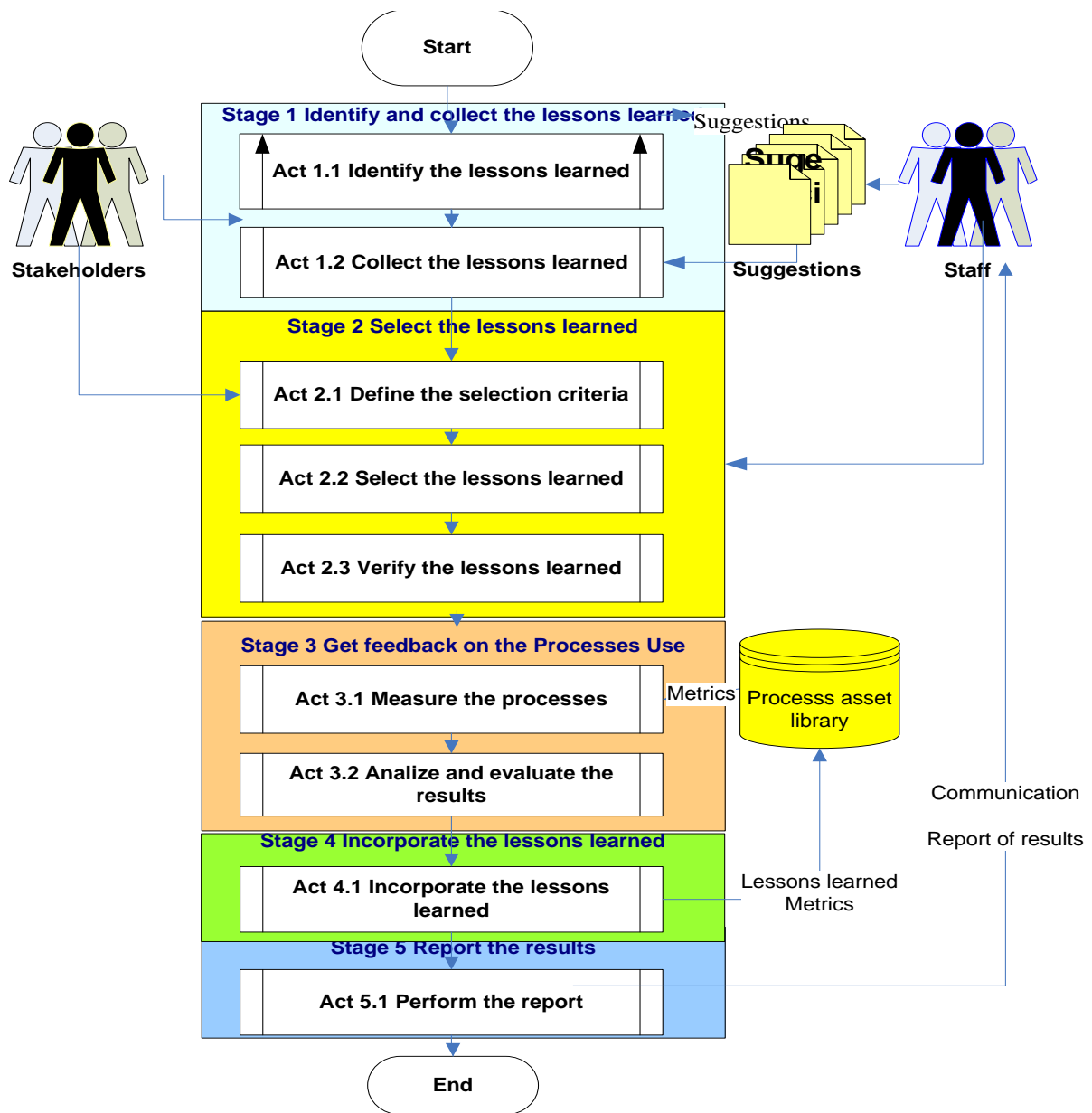


Figure 1. Flow diagram of activities for lessons learned feedback

5. CONCLUSIONS

This article has presented a proposal to identify lessons learned from the process deployment experiences. The lessons learned have identified problems in the deployment process such as training, communication, staff involvement, process definition, to have a formal methodology for the deployment, monitoring and evaluation processes, and top management commitment. It also has identified deficiencies, such as pressure and workload, prioritize projects to processes and staff overloaded with responsibility for two critical processes, among others. Having identified the problems, the organization establishes corrective actions. As a result of driving the deployment process each organization has an intellectual capital accumulated in the minds of people. However, this knowledge is not used appropriately for continued process improvement. It has submitted a proposal to collect and translate these lessons into

practical use in the organization, so that the knowledge of people is managed on behalf of organizational knowledge and lessons learned are incorporated as an asset to the process asset library.

6. REFERENCES

- [1] Chrissis, M., Konrad, B., and Shrum S. 2011. *CMMI Third Edition, Guidelines for Process Integration and Product Improvement*. Addison Wesley.
- [2] ISO/IEC 15504-2:2003. Information technology- Process assessment- Part 2: Performing an assessment. International Standards Organization. Ginebra, Suiza.
- [3] Garcia, S. 2003. Preliminary Insights Working With CMMI in Small Organizations, Proceedings of the NDIA CMMI User's Conference, Carnegie Mellon University.

- [4] International Process Research Consortium. 2006. *A Process Research Framework*. Eileen Forrester editor, Software Engineering Institute.
- [5] Bayona-Ortega S., Calvo-Manzano, J., Cuevas, G. and San-Feliu T. 2014, Critical success factors taxonomy for software process deployment, *Softw. Qual. J.*, Vol. 22 Issue 1, pp. 21-48.
- [6] Messnarz, R., Ekert, D. and O'Suilleabhain G. 2008. Human resources based improvement strategies - The learning factor, *Software process: Improvement and Practice*, 13, 355-362.
- [7] Allison, I. 2015. Towards an Agile Approach to Software Process Improvement: Addressing the Changing Needs of Software Products, *Communications of the IIMA*, Vol. 5: Issue. 1, Article 8.
- [8] Duffield, S. and Whitty, J. 2015. Developing a systemic lessons learned knowledge model for organisational learning through projects, *International Journal of Project Management*, Vol. 33, Issue 2, pp. 311-324.
- [9] Bayona, S., Calvo-Manzano, J., Cuevas, G. and San Feliu, T. 2012. MEDEPRO: A Method to Deploy Processes Focused on People. In *proceedings of EuroSPI*, 13-24.
- [10] Choo, C. 2000. Working with knowledge: how information professionals manage what they know. *Library Management*, Vol. 21 Issue. 8, pp. 395-403.
- [11] Sullivan, P. 1988. *Profiting from Intellectual Capital*, ed 1988, New York: John Wiley.
- [12] McIntyre, S. 2014. *Utilizing Evidence-Based Lessons Learned for Enhanced Organizational Innovation and Change*, IGI Global.
- [13] Brady, T. and Davies, A. 2004. Building project capabilities: from exploratory to exploitative learning, *Organ. Stud.*, 25 Vol. 9, pp. 1601-1621.
- [14] Andriessen, J. and Fahlbruch, B. 2004. *How to Manage Experience Sharing: From Organisational Surprises to Organisational Knowledge*, 1st ed. Elsevier, Amsterdam; Boston.
- [15] Sense, A. 2007. Learning within project practice: cognitive styles exposed. *Int. J. Proj. Manag.* 25, 33-40.
- [16] Zhao, D., Zuo, M. and Deng, X. 2015. Examining the factors influencing cross-project knowledge transfer: An empirical study of IT services firms in China, *International Journal of Project Management*, Vol. 33, Issue 2, Pages 325-340.
- [17] Zahran, S. 1998. *Software Process Improvement - Practical Guidelines for Business Success*. Harlow, England: Addison Wesley.
- [18] Kaltio, T. and Kinnula, A. 2000. Deploying the defined software process. *Software Process: Improvement and Practice* 5 (1), 65-83.
- [19] Wilson, D. and Hall, T., Baddoo, N. 2007. A framework for evaluation and prediction of software process improvement success. *Journal of Systems and Software* 59 (2), 135-142.
- [20] Ferreira, A., Santos, G., Cerqueira, R., Montoni, M., Barreto, A., Soares, A. and Rocha, A. 2007. Applying ISO 9001:2000, MPS.BR and CMMI to Achieve Software Process Maturity: BL Informatica's Pathway. In *proceedings of the 29th International Conference on Software Engineering (ICSE'07)* 642-651.
- [21] Baddoo, N. and Hall, T. 2002. Motivators of Software Process Improvement: an analysis of practitioners' views. *Journal of Systems and Software*, 62 (2), 85-96.
- [22] Madia, F., Dettori, M., Galasso, A. and Iacono G. 2006. Effective Change Management through Integration and Knowledge Governance, Engineering Management Conference, IEEE International, 385-387.
- [23] Sassenburg, H. 2002. Assessing readiness for (software) process Improvement, *Methods & Tools*, Spring 2002, 18-24. <http://www.methodsandtools.com/archive/archive.php?id=35>.
- [24] Niazi, M., Wilson, D. and Zowghi, D. 2005. A framework for assisting the design of effective software process improvement implementation strategies, *Journal of Systems and Software* 78, 204-222.
- [25] Riege, A. 2005. Three-dozen knowledge-sharing barriers managers must consider. *Journal of Knowledge Management*, 9, 18-35.
- [26] Mas-Machuca, M. and Martínez-Costa, C. 2009. Barreras y factores clave en los proyectos de Gestión del conocimiento en las empresas consultoras. *3rd International Conference on Industrial Engineering and Industrial Management XIII Congreso de Ingeniería de Organización* Barcelona-Terrassa, September 2nd-4th.
- [27] Črnjar, K., and Dlačić, J. 2014. Critical success factors for knowledge management implementation in hotel enterprises. *MakeLearn 2014: Human Capital without Borders: Knowledge and Learning for Quality of Life*, 977-984
- [28] Richter, A. and Derballa, V. 2009. Barriers to Successful Knowledge Management. *IGI Global*, 315-321.
- [29] Singh, M. and Kant, R. 2008. Knowledge management barriers: An interpretive structural modeling approach. *International Journal of Management Science and Engineering Management*, 3(2), 14