Maturity Model and Lesson Learned for improve the Quality of Organizational Knowledge and Human Resources Management in Software Development

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***Abstract*—Constant changes created by the global market have led software organizations to depend increasingly on their intellectual capital, its human resources. In this context, the lessons learned are presented as an important resource to aid in the preservation and control of this intellectual capital. This paper aims to present a process model focused on gradually implement activities to improve the human resources management. Furthermore, this is also used to manage and share a repository of organization's intellectual capital, through a stream of lesson learned management. This process model was applied in software house located in a Brazilian public university. Their results showed improvements in both human resource management and in preserving the intellectual capital of the organization. Thus, this paper contributes to the scientific community by presenting a process model focused not only on improve the human resources management but also to increase intellectual capital of the organization.**

Keywords-Human Resources Management; Maturity Model; Lesson Learned; Software Development; Process Quality.

I. INTRODUCTION

Changes in the technological context achieve a high degree of innovation and agility, contemplating men as the protagonist of a new organization history [14]. To assimilate them, a cohesive development process, it is necessary that the organization has a capable team with skills and to propose corrective measures in a timely and effective. These factors emphasize the high dependence of human resources for the development and maintenance of software projects [14], [15]. Several processes and methodologies have been developed to aid in the management of these resources [10], [5], [9].

In similar context, the use of Lessons Learned (LL) during the performance of activities represent an important resource to assist both in the analysis and understanding of patterns, customs and ways of operation of teams and the planning of future projects. In general, they should report the actual result and expected decision detailing the facts and deviations occurred during this journey [1]. Therefore, the quest for maturity of human resource management, the use of LL can bring significant results [4]. In this sense, the objective of this paper is to present a process model to implement activities which improve gradually the human resource management and, in parallel, to increase knowledge about the historic achievement of its tasks and projects developed through the LL. Moreover, the organization analyzing these LL can identify forms and patterns of development teams performance.

In the pursuit of this goal, this paper is organized as follow. First, it's introduced background concepts used in this study. The research method used to develop this paper is brief presented in Section 3. In Section 4 we present the proposed process model. Its initial application is presented in Section 5. Finally, we conclude and present future works in Section 6.

II. BACKGROUND

A. Human Resources Management on Software Development

Several studies demonstrate that holding the best technological tools, using the most efficient techniques and work models is not enough to guarantee the success of a software project [8], [14], [15]. It is necessary the existence, in parallel, of a human resources management (HRM) able to develop skills and guarantee the effective allocation of its members, in order to increase the quality of its process [12].

However, several managers attribute more importance to the technical and practical areas rather than the human resources, which end up by losing the focus in software development processes [15]. Moreover, during the development of a software project, the dynamic in business processes and the high turnover of technologies, and his members highlights the importance to manage intellectual knowledge with creating mechanisms to collect, store and share it [5], [12].

B. Maturity Levels

Maturity models seek to establish levels of development of processes, called maturity levels that characterize stages in the implementation of improvement processes in the organization [2]. Thus, at each step in this journey, the model recognizes and signals the gradual maturity of the organization. Several maturity models were studied, among which we may highlight:

- People Capability Maturity Model (P-CMM): it is a maturity model variant of Capability Maturity Model

(CMM) which has as focus to help in HRM. To do so, it offers a set of good manners to make provisions for the continuous growing of workforce abilities in the organization [6].

- GAIA Human Resources (GAIA-HR): it is a framework composed by a maturity model, services, and diagnostic assessment questionnaire which aims to develop processes and factors that influence on the HRM [9].

C. *Lesson Learned (LL)*

A lesson is a knowledge gained through experience. The experience can be positive (good practices) as a successful test, or negative, as a failure. Both of them are considered lessons. A lesson must be significant, impacting on daily operations [5]. Basically, it is an acquired knowledge by observation or adverse experiences that cause an improvement in organization or to a particular individual.

There are several benefits of applying Lessons Learned (LL) within an organization, Roe [13] and Goes et al. [7] cite some of them: a) Saves time in solving problems, since the solutions of common problems are centralized in one location for easy access by members, b) Helps reduce or avoid costs from rework to correct defects already discovered, and c) Encourages the use of best practices within the organization, which improves the chance of success of the projects.

Can still be characterized as LL, narratives that explain knowledge gained through experience, which can be both positive and negative [3]. The LL record is an excellent way to avoid the mistakes made previously and that the successes achieved in the projects can be copied in future projects.

III. RESEARCH METHODOLOGY

The research methodology used in this paper was a case study. We chose this methodology because it offers an empirical research that offers researchers an object of applied study in its natural context [16]. Table I presents the steps followed on the research methodology.

Table I. Key Steps of Research Methodology

Step 1	**Literature Review**
	Reviewed literature and identified approaches used to develop the HRM.
Step 2	**Process – First Release**
	From this analysis, we elaborated the process first version which is defined its workflow and elements.
Step 3	**Process Application**
	Using this version, the process was applied on a case study.
Step 4	**Results Analysis**
	The results obtained with the case study, we analysis the beneficiates and problems evidenced.
Step 5	**Process – Final Release**
	The items identified on the last step were used to increase or add new elements to the process.

IV. PROCESS MODEL

The process aims to implement gradually activities to improve the HRM and, in parallel, it will increase knowledge about the historic achievement of its tasks and projects developed through the LL. Fig. 1 shows the process model structure composed by eight activities and a LL incremental process. It used an intuitive notation that represents the main objective of each activity. Besides this, the blue arrows represent a connection between the activities, the green arrow sets the flow when the evaluation of services implantation is approved, and red arrow when this it is rejected.

Besides this, we can highlight the conditional step represent by a rhombus shape and its alternatives: (1) if the activity *Services Implantation* is approved the organization follows the green arrow and goes to next activity, *Increase Organization Maturity Level*, or (2) if the activity *Services Implantation* is rejected the organization follows the red arrow and go back planning the services implantation. Next, the process model activities and LL incremental process will be present in detail.

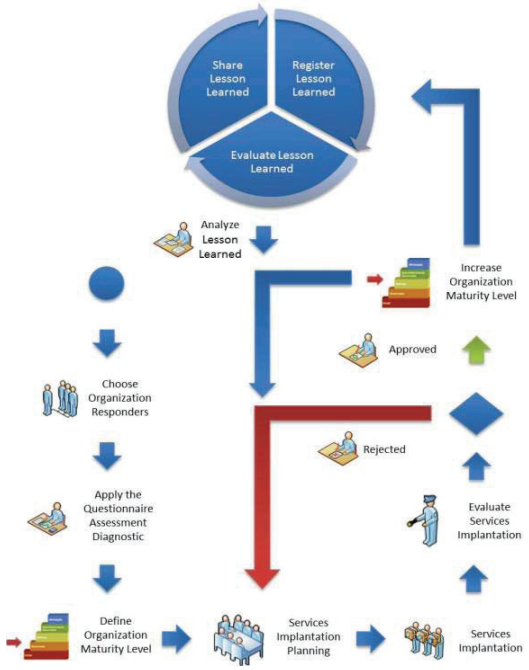

Fig. 1.Process Model for HRM Maturity using LL

A. *Choose Organization Responders*

Since this is a process model to assess the maturity of HRM in software teams, they represent the main actors in this scenario. With this assumption, the people involved this process should be committed to the organization, focusing on maximizing the knowledge and aware of their contribution to the improvement of this management [9].

As the first activity of the process, the choice of members of the organization who will participate in the implementation of improvements in the management of human resources has crucial role to ensure its success. Thus, this team should be prepared according to the following criteria: members aligned to the organization strategy, involved in day-to-day organization, and committed to knowledge dissemination.

B. Apply the Questionnaire Assessment Diagnotic

The purpose of this paper is the implementation of a process that demonstrates the practice of HRM, which can be verified by a suitable questionnaire. The questions should be based on principles that may assess over time. For this purpose we can evaluate both aspects: the skills of workers and the HRM process. For this, we used the models of Diagnostic Assessment Questionnaire (DAQ) presented by Gaffo e Barros [6] (The system used to Diagnostic Assessment Questionnaire (DAQ) can be found on this link: http://www.gaia.uel.br/gaia_ad/).

The result of this questionnaire should reflect the real situation of the organization as to the stage of HRM, this identification of the maturity level institutionalized in the organization, it is resulted by the low achieved index compared using the value range presented on the Table III of Gaffo e Barros [6] (an example of this can be found on Table II, the maturity level institutionalized on the initial application was two because the low achieved index of all services was the mobilize and staff).

Among his important points stand out: (1) human resources management, (2) motivation of the people involved in the project, (3) commitment of employees to project's success, (4) changes that affect people's performance, among others.

C. Define Organization Maturity Level

Based on the tabulation of the questionnaire results, the organization should be framed in a maturity level, thus establishing the landmark positioning of HRM. In this context, it was used the maturity model and services presented by Horita e Barros [9]. Further, the calculations used to define this maturity level were based on Gaffo e Barros [6].

D. Services Implantation Planning

The success of the HRM can be measured only after its effective implementation and evaluation, but the process itself must have a deployment plan. This activity aims to minimize the risk of failure during deployment. Resources should be sized to ensure that the deployment is successful, such as trained personnel and available computational resources, participation of other stakeholders, infrastructure, scheduling for each task, among others. The LL is also one of the techniques to be planned from the explicit knowledge to its spread, considering the experiences of success and failure.

E. Services Implantation

This is one of process model main activity, it is put into practice the tasks defined in the previous activities. Moreover, it is necessary to identify possible adjustments to maintain the initial goal. In this activity, the responsible persons should have a fundamental role to monitor the tasks safely and in line with the planning. However, it should also be prepared to take corrective action to adjust the faults that may occur during deployment.

F. Evaluate Services Implantation

The assessment roll is the activity in which you will be indicating whether the services were implemented properly and according to plan, i.e. it shows whether they are satisfactory, if adjustments need or are disapproved.

This review can happen through a new application of DAQ, through the application of personal interviews with selected staff in the activity, Choose Responders Organization, or applying a checklist evaluation [5].

G. Increase Organization Maturity Level

Improving HRM in the organization is a natural result of the evolution process. Therefore, it is necessary to perform new challenges to improve HRM, shortly after positive evaluation. Thus, this activity directs the organization to record the activities executed at Implantation Planning Services to define new services being deployed.

H. Lesson Learned Process

The activities proposed in this process model are based on the LL cycle. Planned in four stages, three of them are executed on a cycle form - register, evaluate, and share - and last one executed when a specific lesson are required. Initially, the registry is the explanation of the experience transformed into knowledge for possible use by others involved [13]. From the recorded knowledge, this is validated according to the requirements and criteria for the LL management.

Then the LL is disseminated to feed new lesson and ensure that the experiences will be useful to others involved in software development. According Alvarenga Neto [11], sharing the LL can happen by several media: internet, intranet, and groupware information repositories. On each evolution iteration of organization' maturity level, the LL are analyzed and effectively used to improve the software development process. Therefore, the process model provides a LL analysis to drive improvement in the organization.

V. PROCESS MODEL APPLICATION

In order to validate the process model on the case study, we selected one simple project of software house in a public university. This project was composed by seven use case defined with customers. Its development team was composed by four undergraduate, one master student with a medium knowledge on software development, test, and requirements elicitation. This team used a development process based on Project Management Body of Knowledge (PMBOK).

As defined by the process model, initially, DAQ was applied on the current members of development team and members of previous projects. These previous participants were selected using a simple questionnaire sent by email asking to these members participate of this questionnaire application. This application happened on Jan/2012. For this, we used the tool cited at Section IV.B.

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In Aug/2012, a second DAQ application happened to the software house. This application aimed to validate and identify areas where improvements in services have been deployed and how to detect those needing improvement and redesigns. However, this time, were adopted as respondents, members other than those selected for the initial application, but they were involved in project used as case study. Table II shows the service rate achieved and a comparison with the initial rate.

Table II. Adherence Index on Final DAQ Application

Services	Initial Index	Final Index	Evolution of Index
Manage Human Aspects	32,81%	68,75%	35,94%
Manage Performance	29,06%	58,55%	29,49%
Knowledge Management	26,14%	49,24%	23,10%
Manage Training	31,64%	52,82%	21,18%
Mobilize and Staff	23, 67%	53,00%	29,33%
Human Resources Plan	33,12%	54,06%	20,94%
Review the Business Needs	25,93%	53,70%	27,77%

After analyzing the results of initial application of DAQ, it was evidenced the necessary improvement on three services (highlighted by underline). Because of low index of mobilize and staff it was gives to the organization the maturity level two. From data shown by Table II, after the implementation of the services suggested, it is highlighted the rates achieved by focus areas all of them showing a growth above 20%. The attendance rates achieved have also enabled the migration of HRM software house for the level of maturity of three maturity model since the lower rate is 49.24%.

Besides this, it was also used to analyze the LL one indicator that aims to provide growth in the level of knowledge managed by the organization after the framework implementation. To do so, are compared and analyzed their contents generated with those approved. This approval aims to ensure that they are stored only those relevant to the aid of the projects. Fig. 2 shows this indicator for the case study.

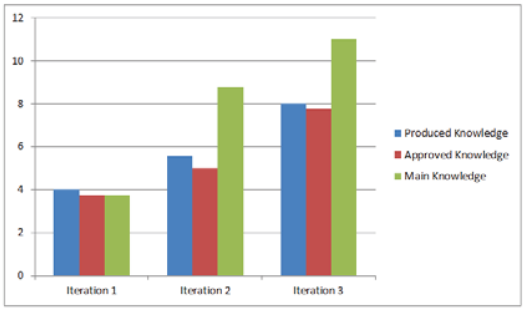

Fig. 2. Produced Knowledge vs. Approved Knowledge

As shown in Fig. 2 through the process model implantation, we identified an increase of 65 % in the project selected as case study. In addition, this analysis can emphasize the increased production of knowledge qualified to be stored and used in future projects of the organization.

VI. Conclusion and Future Work

This main contribution of this paper is to present a process model to improve the activities in human resource management and to increase the historic achievement of its tasks and projects developed through the LL. Moreover, LL analyzing aims to understand the performance patterns of development team and help on future projects planning.

The experience of process model applying was possible to evidence his efficiency on improving the activities of human resource management in software house used as case study. Furthermore, when it was used together on an evolutionary HRM process, the LL cycle showed efficient by analyzing the indicator associated. In future lines of work, we will try to apply the process model on other companies and we intend to integrate the multi-criteria analysis to help on identify, filter, summarize, and select the set of the best LL created.

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