

# APPLYING LESSONS LEARNED AS AN IMPROVED METHODOLOGY FOR SOFTWARE PROJECT MANAGEMENT

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## ABSTRACT

Considering the causes of failures in project management, this paper aims to apply lessons learned techniques seeking to provide the efficiency and effectiveness of the results in the software development and management. For this, techniques have been developed during the project based on Knowledge Management, Knowledge Engineering and Maturity Models. Still in this article will be specified the applicability of these fundamentals in managing software projects, taking into account the lack of management problems in the knowledge management process focusing on the difficulties encountered by companies in the dissemination of knowledge.

## KEYWORDS

Lessons Learned, Project Management, Knowledge Management, Organizational Culture.

## 1. INTRODUCTION

Lessons Learned (LL) is considered the content domain of the people of an organization and itself, where this knowledge was acquired by one's own experience of the project team. A LL may have influence outside the organization due to the participation of other persons or for research in other documents. Goes and Barros (2012) define LL as a resource of information storage in the own organization.

One of the factors that hinder the creation of an organized structure for storing knowledge in the organization is the diversity of information sources. With this in mind, this paper proposes using Lessons Learned to optimize these difficulties. The sources of information may be internal or external to the organization, in any of these is the need for their classification. They don't always contribute or form part of the scope of the organization, which requires at least be related to company matters.

Although project management has a diverse and extensive list of techniques to accomplish their goals and achieve project success. There are specifics in knowledge management that can be supplemented to improve software development. For each activity performed by members of a project team may have one or more LL to be considered, increasing the level of success of this project.

So with systematic practice of LL, the proposal is that the project management becomes an activity with greater assertiveness. Thereby, it is possible to achieve higher accuracy in time, better results in software quality and forecasts adequate resources.

To this end, this article has been divided as follows: Section 2 is a literature review on managing projects and lessons learned. Section 3 presents a study and related work, as well as the presentation of a comparison table. In section 4 are the results of the proposed features. And finally in section 5 is the conclusion of the application of this study and future works.

## **2. LITERATURE REVIEW**

In the process of literature review were done numerous studies on the two main aspects of this work, Project Management and Lessons Learned. For this, it conducts a diversified search, seeking relevant and current sources in the literature. Yet, also as part of this review, but in chapter 3, a study was conducted on similar works in order to structure and qualify the proposal of this work.

### **2.1 Project management**

The projects are key tools for any change activity and generation of products and services. They can involve a single person until thousands of people, organized in teams, and have a duration of a few days or several years (Torreão, 2005). Martins (2003) notes that they are planned and implemented by organizations to create new products and services as well as introducing changes and innovations in their processes. And the need to systematize and guide how to manage organizations motivated the development of management techniques.

Due to its characteristics multidisciplinary, the discipline of project management (PM) has been developed in several areas, such as engineering, general administration and military, to be recognized as a branch of study itself (Dinsmore and Cabanisbrewin, 2006). The growth of project management refers to topics such as roles and responsibilities, organizational structures, delegation of authority, decision-making and especially corporate profitability (Kerzner, 2003).

The most widely accepted definition for the term "project" is presented by the PMBOK, characterizing it as "a temporary endeavor to create a product, service or result only" (PMI, 2004). In the same vein, Westland (2006) defines it as "a unique venture to produce a set of results according to constraints of time, cost and quality clearly defined."

Thus, the project management "is the application of knowledge, skills, tools and techniques to project activities to meet project requirements," (PMI, 2004) (Westland, 2006) that can be explicit (needs), or implicit (expectations). Management activities grouped in a coordinated set the project lifecycle. The project lifecycle involves the activities of project management, and product life cycle involves the activities of product development (Dinsmore and Cabanisbrewin, 2006).

The activities of product development vary by branch of industry (software, pharmaceutical, manufacturing, etc.). But the activities of project management not. These can be classified into groups, called phases. For example: initiation, definition, planning, execution, control and closure. Each stage brings together activities with similar purposes.

### **2.2 Lessons learned**

A lesson is knowledge or understanding gained through experience. The experience can be positive (good practices) as a successful test, or negative, as a failure. Both successes and failures are considered lessons. A lesson must be significant, impacting on daily operations (SOFTEX, 2008). 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 within an organization, Roe (2011) cites some of them:

- Saves time in solving problems, since the solutions of common problems are centralized in one location for easy access by members.
- Helps reduce or avoid costs from rework to correct defects already discovered.
- Encourages the use of best practices within the organization, which improves the chance of success of the projects.

Can still be characterized as a lesson learned narratives that explain knowledge or understanding gained through experience, which can be both positive and negative. The lesson relates what was expected to happen, the facts and deviations occurred, the analysis of the causes of these deviations and what might be learned during the process (Brett, 2000).

The record of the lessons learned is an excellent way to avoid the mistakes made previously are avoided and that the successes achieved in the projects to be copied in future projects. According to Aldenucci (2009), five points are listed for successful implementation of the process of documenting lessons learned:

**Educate members of the organization** - it is necessary to break the paradigm that the gathering and recording lessons are a waste of time and bring awareness of the benefits that sharing information brings to the organization. For this process to work, the sponsorship is very important to generate motivation and engagement. According to Brett (2000) for the full use of knowledge management practices in a company, one of the key factors is the involvement of stakeholders and the workforce, which involves a change of culture.

**Collect and record experiences** - this is a task considered costly and demand great effort by the team. It is essential for this task to be performed using methods and practices that are oriented and easy documentation of items relevant to the organization, it is also important that these items are organized following a set pattern.

**Analyze successes and failures** - not enough simply to record and catalog the lessons learned is also necessary that these lessons are understood and analyzed. Identify the actions that contributed to good results and analyze what went wrong and why give the opportunity to understand and contextualize these records in order to take steps to improve when necessary.

**Disseminate knowledge** - is not enough to just save these lessons should be disclosed throughout the organization. But this disclosure must take into account the direction and prioritization of such information in accordance with the interests of each group.

**Keep updated records** - It is very important to understand that the registration process of the lessons learned should be cyclical, i.e., it must be constantly updated.

### 3. RELATED WORK

In the area of information technology much research has been conducted focusing on lessons learned. Among them we can mention the architectural model (Andrade et al., 2013), which proposes the use of a model to manage the lessons learned in the testing phase. In it is defined a structure to support the use of lessons learned during this phase. Along with this structure they proposed a set of procedures to manage it through a tool for this purpose.

Rogers et al., (2007) prepared a guide containing major errors in the process of lessons learned. This topic was much discussed in the NASA (National Aeronautics and Space Administration) especially after the incident with the space shuttle Columbia. In this guide, the authors focus on the three main stages of the process, they are a collection of lessons, managing and implementing them in future projects.

In the work of Mendoza and Johnson (2006) the lessons learned process is used to develop and maintain an organizational memory in a NASA research center. This center develops high-risk systems. Through the use of interviews, decomposition and reintegration of tacit knowledge to explicit information gathering and dissemination using them managed to establish a process and obtained good results after its implementation at the center.

Following this line Seaman and Basili (2003) use the lessons learned process as a means of disseminating knowledge within the software engineering, aiming to create a community of interest. This work describes the operation of the engineering center software based on COTS (Commercial Off-The-Shelf) and how the lessons learned are used. Together there is a detailed description of a repository of lessons learned from development plans for it.

The lessons learned can also be used within a larger context of knowledge management, as described by Goes and Barros (2012). In their paper, the authors describe a corporate portal composed of eight modules that manage knowledge within a software factory. The focus of the work was on lessons learned module, where a model was developed to manage the lessons within the portal, along with a tool that implements.

As can be seen, the use of lessons learned in the area of information technology is well discussed in the literature. Many of the works give focus on lessons learned process and how this can be useful, but few define it. And even those who do, their deployment process is not usually evident.

Therefore, intending to fill this gap, this paper aims to propose a process of implementation of lessons learned within an organization as a methodology for improving the management of software projects. Thus facilitating the day-to-day project manager in their everyday operations at the time of decision making.

Also as part of this approach in the literature on related work was done to build a comparative table. From the main research methodologies in project management, focused on software development, it was possible to raise the features in the use of LL Based on this research was elaborated comparative table (Table I) that cites how each methodology contributes to the success of a project. The next subsection contains a brief description of the issues that motivated the creation of the comparative table.

### **3.1 Description of the comparative table**

When it comes to building a knowledge base, (Basili, 1996) the CEBASE (Center for Empirically Based Software Engineering) defines what is necessary to define and improve methods of construction of LL Employing resources and proper techniques in organizations can achieve concrete results and positive projects in software development.

The Organizational Culture has essential influence on the process of creation and use of information management and knowledge (Nonaka, 2000). The acquisition of knowledge is an evolutionary process that people realize the difference between practice and theory. In the organization, this perception is perceived from the explicitness of information and knowledge.

Among the tasks assigned positions in the workforce, in an organization, it is important to have defined the bidding activity of LL. The integral of a software project goes through unique experiences throughout the project, this experience can become a LL for organization. Widely described in PMI (2008), the use of LL is ranked as one of the organizational process assets.

While the PMBOK describes the importance of LL for future use, when properly explained, ITIL emphasizes as an Active Knowledge of cost. If you believe that the formation of LL is based on information lived within the own project, we conclude that these inputs have zero cost.

The interrelated elements in the knowledge construction can be used in various ways by low cost. Having a knowledge explicit (McLean, 1999) can relate one to the other, have the complement of one to the other. It is common knowledge that one use knowledge information from another, thereby creating a dependency between them (Schreiber, 1994).

One of the properties of great importance LL is related to the ease of recovery after this storage. It is useless if there is the explanation of a guard and LL, if, when trying to use, have impairments or difficulties in access. In all the cited methods are surveyed the need for storage, but only in CMMI is described for ease of recovery of LL.

But for every situation in different projects this LA must be validated for their efficiency or effectiveness, in view of the restrictions and requirements or this project. For this it is necessary that a procedure be established and followed to be applied to each scenario. Thus, following criteria according to the project as restrictions on scope, quality and requirements, as shown in Table 1.

Therefore according to Table 1, the effectiveness of using LL is related to communication. Knowledge workers have a need to express their feelings. Thus efficient communication can positively influence the use of a facility in LL. Besides the use of tools to seek an LL, it is extremely important that the person is motivated to use it.

Also according to Table I can recognize that such items addressed reflect the reality of companies that possess the knowledge as one of its organizational assets. And with the implementation of these proposals realize the benefit of using the technique of applying the acquired knowledge in future projects.

Table 1. Comparative of Methodologies and Technologies with Developed Proposals

Criteria	SCRUM	RUP	COBIT	PMBOK	ITIL	CMMI	MR-MPS	Developed Proposals
Management Support of LL is a process Cultural of the Organization	One goal of the meeting is the retrospective survey and practice of LL.	For each phase or stage of the RUP are described for capturing lessons learned, project management, iteration plan, test planning, evaluation iteration, among others.	Not Specified	In all managements are cited the need for use of LL. Especially when the item describes the organizational process assets..	In service design p. 344, additionally mentions that the skills, aptitudes and skills should be incorporated into roles and responsibility. On p. 33 service strategy. Pattern, specifies that it must have the description of decisions and actions taken over time.	Establishes a process defined as sub practice, p.115, the inclusion of the lesson learned in the library organization	In GPR, p.46, quotes superficially the need for management conformance.	Using LL activity continues as before and after the execution of the tasks of project control
Procedure for transformation of Tacit Knowledge to Explicit	Not Specified	Not Specified	Not Specified	In quality control, p. 180, describes how to execute the documentation of LL. Also clarifies the use for future projects, p.186, describing how the format should be text.	On p.325 service strategy, Knowledge, Knowledge Assets quotes to leverage results with zero cost. And may include policies, projects, configurations, architectures, process definitions, analytical methods, service	Not Specified	Not Specified	Establish explicit LL model based on authorship and references, with the fundamental classification Positive or Negative.
Tool for storing LL has ease of use	Not Specified	Not Specified	In PO10.14, p. 76, states that to complete the project, and documentar should identify lessons learned for future programs.	Establishes two categories of assets: processes and procedures and corporate knowledge base. The LL is specified in this second category.	In service strategy p. 120, Retired service, for future use, the services can be stored once they are completed.	When specifying the process of storage of LL, need to define criteria to ensure ease of recovery in LL (p.193)	In GPR, p.46, has a generic item for data relevant to the project are identified and planned as to, storage and destruction.	The storage of LL must have full availability and resources for automatic search, including the LL referenced, with classification phase of the project life cycle. For each modified LL, project members should receive.
The management of LL is included in CM (configuration management)	Not Specified	Not Specified	Not Specified	In corporate knowledge base p.36 establishes configuration management.	On p.100 service strategy, service standards, should be placed under configuration management to be standardized, stabilized, improved.	Not Specified	Not Specified	Must maintain the history of changes made to each LL with search facilities.
The storage system of LL has access control policy	Not Specified	Not Specified	In PO2, p.41 establishes the classification scheme of data (general) with access control, archiving or encryption.	When executing the distribution of information, the LL is cited as one of the information being disseminated.	On p.325 service strategy, Knowledge, can be treated as intellectual property and is protected by copyright, patents and trademarks. And also can be rented for use under licensing and service contracts.	Not Specified	Not Specified	Access to the repository of LL must have control by project members
The spread of LL has defined procedure	Not Specified	Not Specified	Displays only need to communicate LL at the end of the project, but without specification of	Preve distributing information LL, p.217, but does not determine need for procedure	Not Specified	Has generic quote for dissemination of good practice	Not Specified	The modified LL must be communicated to all project members, classified by positive or negative
The results of LL are incorporated in the products and services of the organization	Not Specified	Has specification for Phase Test	Are provided for the use of LL for process improvement, but has no specification for the	In defining the scope, p.39, is expected to use LL.	Not Specified	Not Specified	Not Specified	For each LL used in developed products should have the association of use.

## 4. ADVANTAGES OF LESSONS LEARNED IN PROJECT MANAGEMENT

Based on the issues raised and described in Table I and in the proposal, a study was conducted about the main advantages that its use can provide in the application of lessons learned in project management. To this end, according to literature, based primarily on Gôes and Barros (2012), Roe (2011), Andrade (2013) and Rautenberg (2011) can be detached three major advantages in their use, these being listed in subsections 4.1, 4.2 and 4.3.

### 4.1 Organizational culture

At instant that people are discussing about a solution of a possible LL the understanding becomes fast. But as time goes on, and the longer the time go back to discuss the LL the understanding becomes slower. By providing for the use of the lesson, the organization, as ongoing activity in higher frequency, the results will become more evident and effective.

Just as planned by ITIL, the purpose of this article is to have explicitly defined the responsibilities of each role model in the use of LL. So, the lesson will be practiced continuously before and after analysis of the decision. Will be ensured cultural practice in the use of LA especially when the senior applies this practice in everyday life in the organization. Thus, the example will make all other hierarchical levels follow this model.

The integration of the organizational structure with the Knowledge Management (Rautenberg, 2011) it is important to have competitive advantage. Thus the need for each situation can be applicant, giving the opportunity to use the lesson as a means of storing knowledge.

Those involved in the project can better understand the efficiency of applied LL in project management, when check that the characteristics of the final product shows parts of an LL. Effectively can be observed by the features, design pattern, software behaviors, among others.

## 4.2 Ease search by tools

The ease in retrieving a LL is related to the form and method in which it was stored. Multiple entries can be retrieved for the same search term, so that the search becomes efficient and complete, returning a complete picture with all matters pertaining to the term in question.

In the models studied, we could not find an explicit description for a minimum criterion in order to facilitate the retrieval of stored LL. In CMMI, reports that recovery from LL should have criteria to facilitate recovery, but does not show how it should be done this procedure which aims to recover data registered.

Thus, this proposal provides that the searches should be available in real time, so that people can run them without efforts to remember. Currently, there are features that facilitate both visualization and help seeking, as much for the templates as to the corrections in certain activities.

These resources are present in tools worldwide known, such as the navigation software on the internet (browser). We can mention two simple cases when you hover the mouse over a button of a window. In the first, we present additional information that help to decide by this operation. In the second, are listed options that add extra procedures or values for a particular operation.

In project management, to realize that there is a delay in schedule, the tool could alternatives to resolve this situation, based on LL. In the same way, the tools of project management could offer these features for more efficient use of projects in previous LL.

## 4.3 Configuration management

The history of an LL, properly arranged in a configuration management, to become effective decision-making. When comparing a modification projects conducted in the past, the manager can analyze the effectiveness of LA for that situation. And, compared to a situation when necessary, can also decide whether the same lesson is applied or not.

The members of each project may access the collection of LL according his responsibility. It is important that each lesson has its applicability defined according to its purpose in the same way, people will have access only to a particular application.

With that, creates inside the database of the organization responsible for the storage of one LL, the versioning represented each lesson. Being that if a lesson has already been registered, you will not need it registers it again, just need to add a new version with the modifications to be made.

Consequently, it creates a comparison between a version with an item registered the previous projects. For example, when doing an analysis and generate an artifact (use case), may have a relationship with a LL which in turn could be sure that when we prepared this artifact was generated with the "n" version of LL, thus realizing the full control of the use of the lessons in the projects.

## 5. RESULTS

Through the process of evaluation of the proposal, for people involved in software development such as project managers, it was possible to tabulate a satisfactory result. This process was implemented in three phases, with the first presentation, then the application of the assessment and evaluation of the final tabulation.

As proposed by Rautenberg (2011), the methodology for collecting the results were submitted to three groups of people: specialists, non-specialists and project managers. Those who know and study deep knowledge management are classified as experts. Getting as non-experts, the other participants of the software factory GAIA. And finally, those who know and practice the management of software development projects.

For the evaluation, questions were presented in which participants could analyze the applicability of the proposals of this article. Each question has with goal verify whether the benefits proposed for LL would be effective in the management when applied in real projects.

From the questions presented, the evaluators described statements that evidence that the proposals for this article, be applied would be effective. Follows in Table I the statements prepared by the evaluators.

Table 2. List of statements of the evaluators

N°	Statements
01	The research facilities of an LL will be efficient in use.
02	With a choice of a LL to perform a task, the team will be encouraged to explain their experiences.
03	There will be confidence in LL when possible to compare the application on similar projects in the past.
04	Is it possible check the progress of an LL through the records in each version used.
05	With the access control of the LL will be assured that there will be no misuse.
06	The tools option indicating LL at each stage of task will show efficacy in the spread.
07	The association of LL with the records of a product version, ensure that it was part of a feature of the software.

Encouraged by questionnaire and by the proposals, the evaluation participants could respond with alternatives ranging from 1 to 5. Where, 1 represented "no advantage" and 5 "guaranteed benefit." From these responses, the tabulation was performed to find an average of 4.44, which assures us that there is effective use of this product proposals in 88.8%, as shown in Table 3.

Table 3. Tabulation of the results of the evaluators

People Surveyed	Score						Average
Specialists	5	4					4,5
Non-specialists	5	5	4	4	3	5	4,33
Project Managers	3	5	5	5			4,5
Total Average							<b>4,44</b>

At significant result, presented in this sampling specialists, non-specialists and project managers, we conclude that the proposals can be applied to make more effective project management.

Looking at Table 3, verified that the difference between specialists and non-specialists was only 0.17 (or 3.4%) and there was a tie between specialists and project managers. Thus it is concluded that the use of the proposals apply to the three groups.

## 6. CONCLUSION

Using Lessons Learned integrates and works as a tool to aid in Knowledge Management in Organization, this management brings a gain that is directly linked to Project Management. Allowing employees access to previous experiences in organization contributes to the improvement of results obtained in future projects.

This management reflects the evolution the of the organization where the desire to correct past missteps and perpetuation of actions that reflected good results represents an often routine of process improvement.

The proposals contained in this work, which were the result of a literature search of best practice lessons learned in conjunction with the main requirements encountered in project management, proved invaluable.

This fact can be seen in the results of the questionnaire, where experts and non-experts evaluated whether the proposals would be effective if they were implemented.

In future work we intend to evaluate the implementation of the proposals within some organizations and analyze the results. And with that establish a framework for the deployment and management of lessons learned oriented software development.

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