

T HE CONTRIBUTION OF A MODEL TO ESTIMATE ACTIVITIES IN SOFTWARE PROJECTS BASED ON LESSONS LEARNED

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Abstract

Purpose – The main objective of this article is to propose the use of a model developed by Matturo and Silva (2010) to capture knowledge in software projects based on the lessons learned.

Design/methodology/approach – We carried out a qualitative research from a descriptive perspective through a single case study applied to an Enterprise Information Technology company. The company is a leader in market solutions to support customer experience management. For the data collection process, we used systematic literature review, document analysis and semi-structured interviews.

Findings – The results supported project managers to better understand the storage and use of information from lessons learned in dimensioning the use of human resources and to support the estimation of new project activities. In addition, the results showed the organization's disregard for not giving due importance to the information and knowledge generated during the life cycle of a project.

Research, Practical & Social implications – The model allows companies to obtain new knowledge or consult existing knowledge throughout the life cycle of projects and to support project managers in the process of estimating activities and preparing budgets with greater precision, using the information from lessons learned as a support. acquired in the completed projects.

Originality/value – The lack of information in the initial scope of the project and in the definition of activities in the human resource allocation process hinder the duration of the project's development activities, directly resulting in inaccurate estimates. As a result, this scenario contributes to the increased risk of deviations in terms and / or costs of software projects.

Keywords: Activity estimates. Lessons learned. Project management. Models. Software projects.

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A CONTRIBUIÇÃO DE UM MODELO PARA ESTIMAR ATIVIDADES EM PROJETOS DE SOFTWARE COM BASE EM LIÇÕES APRENDIDAS

Resumo

Objetivo: O objetivo deste artigo é propor a utilização de um modelo elaborado por Matturo e Silva (2010) para a captura de conhecimento em projetos de software com base nas lições aprendidas.

Método: Realizamos uma pesquisa qualitativa de perspectiva descritiva por meio de um estudo de caso único aplicado a uma empresa de Tecnologia da Informação Empresarial. A empresa é líder em soluções de mercado para apoiar a gestão da experiência do cliente. Para o processo de coleta de dados, utilizamos revisão sistemática da literatura, análise documental e entrevistas semiestruturadas.

Originalidade/Relevância: A falta de informações no escopo inicial do projeto e na definição das atividades no processo de alocação de recursos humanos dificultam a duração das atividades de desenvolvimento do projeto, resultando diretamente em estimativas imprecisas. Com isso, esse cenário contribui para o aumento do risco de desvios de prazo e / ou custos dos projetos de software.

Resultados: Os resultados apoiaram gerentes de projeto a entender melhor o armazenamento e uso das informações das lições aprendidas no dimensionamento do uso de recursos humanos e para apoio nas estimativas de atividades de novos projetos. Além disso, os resultados mostraram o descaso da organização em não dar a devida importância às informações e conhecimentos gerados durante o ciclo de vida de um projeto.

Contribuições teóricas/metodológicas: O modelo permite às empresas obterem novos conhecimentos ou consultar os conhecimentos existentes ao longo do ciclo de vida dos projetos e apoiar os gerentes de projetos no processo de estimativa das atividades e na elaboração de orçamentos com maior precisão, utilizando como suporte as informações das lições aprendidas adquiridas nos projetos finalizados.

Palavras-chave: Estimativas de atividades. Lições aprendidas. Gerenciamento de Projetos. Modelos. Projetos de software.

1 INTRODUCTION

The estimation process is intended to measure the duration of the activities or work period that will be crucial for the realization of individual activities based on the estimated resources (PMI, 2017). Resources such as materials, equipment, costs, and even humans who consume working time in activities (Cho, 2006), can be applied to any project as well as in various industries and organizations. The challenge for organizations is to achieve better control and use of existing resources in search of project performance increase (Kerzner, 2009).

However, the lack of initial scope of the project and the activities in the resource allocation process, difficult making the duration of the project development activities, directly resulting in imprecise estimates. As a result, this scenario contributes to the increase in respect of term deviations risk and/or project costs (Tastekin, Erten, & Bilgen, 2016). To better understand the impacts of estimates in software projects, Flyvbjerg and Budzier (2011) pointed out that 27% of projects had cost or schedule changes, and that 1 in 6 projects exceed by 70% the time, and about 200% planned cost. This kind of situation is evident because the variations from estimates and the misuse of resources.

Thus, it is expected to capture and analyze the lessons learned in projects, to create knowledge, leverage existing knowledge, and use them as the basis or foundation for organizational procedures and future projects (PMI, 2017). In this context, this study aims to answer the following research question: "How knowledge capture model based on lessons learned can contribute to the process activities estimates on software projects?". To answer this question was determined as research's aim to propose the use of a model elaborated by Matturo and Silva (2010) for capturing knowledge on software projects based on lessons learned. Expected results of this survey contribute towards project managers to understand better the store and use of the lessons learned information in scaling resource use, which can support the activities of the estimate process.

This research is justified by its topic importance and its contribution to the best estimates of resource utilization, from the usage of lessons learned. Corroborate with this idea we can cite the studies of Santos (2014), Chaves et al. (2016), PMI (2017), and Winter and Keys (2017), which point out that the lessons learned are efficient methods that need to be specified and written in protocols to be used as knowledge transfer capabilities. To Tastekin, Erten, and Bilgen (2016), when data from previous designs are available in the company, you can perform a similarity analysis and re-use requirements as input information to estimate the development of new projects in duration. Therefore, the transfer of knowledge obtained during the execution of each project provides process improvement.

This paper is organized into six sections: the next section presents the theoretical foundation that served as the basis of study for the construction of the pillars that support this study. The third section provides the details of the methodology and research procedure that ensures the rigorous methods used to conduct this study. The fourth section presents the results, while the fifth section presents the results discussion. Finally, the sixth section offers the conclusion and their contributions, followed by the references used in this research.

2 THEORETICAL BACKGROUND

This section presents in summary form the main concepts of project management and the relationship with the activity estimation process on the knowledge management and lessons learned in projects, ending with the models of lessons learned in projects.

2.1 Project management and the activities of estimates

Project management is considered a set of good practices applied through knowledge, skills, tools, and techniques related to project activities to meet their requirements and providing organizations to run projects effectively and efficiently (PMI, 2017). However, the applicability of these good practices require evaluation by organizations, because of the way that resources are managed, the result of an organization may not have the same effect obtained by other organizations (Kerzner, 2009; Tereso et al., 2019). This scenario leads project managers to use their knowledge and experience to develop the activities of estimating a project, considering the expert judgment to obtain reliable results (Tan, Yap, & Yap, 2012).

However, in this type of situation, it is reasonable to experience relevant deviations estimates of project activities, resulting in an impact on the delivery of projects, and may also affect the quality of delivery and the rising cost of projects (Dey, Kinch, & Ogunlana, 2007). This situation occurs due to the fact the activity estimation process, according to PMI (2017), be related to assessment of the limitation of resources, including human resources available in the organization to perform several activities.

2.2 Knowledge management and lessons learned from projects

Organizations use knowledge management to obtain the knowledge-sharing contribution of its people, from communication or writing (King Jr & Marks, 2008). According to BJORVATN and WALD (2018), the presence of knowledge as a learning process in innovation projects and preparation of products is considered essential in the integration of the project life cycle. However, it is noteworthy that the perception of knowledge management within the project management topic is still considered underdeveloped, which requires further examination of this issue (Ali, Musawir, & Ali, 2018).

The main benefit came from managing the knowledge of the project, according to PMI (2017), is the ability to use the knowledge from previous projects to produce and refine results, supporting the operations of the project and future phases. In this sense, the organization that acquires learning continuously can generate new knowledge, applying them to new processes as a form of lessons learned.

Lessons learned seek to gather information on the results taken from the project management process to provide solutions for a better performance of future projects (Chaves et al., 2016; PMI, 2017; Winter & Keys, 2017). However, not always lessons learned obtained from projects are documented or communicated for later use. This behavior may cause various problems in developing the project as high costs, long timelines, communication problems, rework, and possible failures (Jugdev, 2012). To elucidate the severity of this scenario, Williams (2008) states that the high level of organizational maturity in project management is quickly reverted to the lack of maturity because knowledge is lost and the mistakes of the past are likely to be repeated.

2.3 Models to capture lessons learned from projects

Organizations have taken lessons learned as methods or models to improve project management processes seeking to maximize project success rate (Santos, 2014). Some techniques, such as post-project review (Goffin et al, 2010; Harrison, 2002), the postmortem analysis projects (Birk, Dingsoyr, & Stalhane, 2002; Scott & Stålhane, 2003), and the semi-structured interview (Komi-Sirvio, Mäntyniemi, & Seppanen, 2002), are seen as effective mechanisms that enable to identify, capture, and transfer the knowledge of key lessons learned and likely to be used to benefit future projects.

The use of models allows organizations to standardize their processes throughout the project life cycle. Some models that address the lessons learned as a source of knowledge in projects are available in the literature, as the models found in this research are presented by Abdellatif, Capretz, and Ho (2019), Tahir et al. (2018), Guzman et al. (2013), Casey and Richardson (2009), Andrade et al. (2013), Papatheocharous et al. (2017), and Matturro and Silva (2010).

Abdellatif, Capretz, and Ho (2019) present an automatic search model lessons learned. Tahir et al. (2018) show a model of success factors for analyzing the measurement practices of lessons learned. Guzman et al. (2013) suggest a model using a project knowledge management strategy. Casey and Richardson (2009) present a model of implementation of lessons learned. Andrade et al. (2013) propose a model for the realization of software testing using lessons learned. Papatheocharous et al. (2017) suggest a model to manage cost estimates of software projects, and, finally, Matturro and Silva (2010) show a model to capture and manage knowledge and experience in software projects.

Knowing the behavior of each model is possible to understand the main characteristics of each one in the treatment of lessons learned as a source of knowledge in projects. In the next section we preset the methodological process.

3 MATERIALS AND METHODS

This research structure starts from the standpoint of a descriptive nature, following a qualitative approach using the strategy case study research and data collection through semi-structured interviews. The descriptive perspective allows to analyze the particularities of a given population or phenomenon by applying standard techniques for gathering data (Gil, 2008). With the application of the qualitative approach, this research was concerned with the alignment between collection and interpretation of data to understand the phenomenon studied in-depth, performed from the perspective of the participants being studied (Godoy, 1995; Neves, 1996; Creswell, 2010).

Intending to provide an overview and a greater understanding of the proposed issue, we adopted the single case study research strategy. According to Yin (2015), the case study is a scientific research method applied to understand processes in social complexity in which they are presented both in problematic and in successful situations. Thus, the author points out that the result of a case study can provide comprehensive and detailed knowledge collected through in-depth researches.

For the process of data collection, we used techniques of systematic literature review, document analysis, and semi-structured interviews. The systematic literature review uses sources such as collections, periodicals, newspapers and magazine articles, Web sites, among others (Pizzani et al., 2012). In the documentary research, primary documents of all kinds were analyzed, whether written or not, including information and evidence materials that have not yet passed through the analysis of a researcher or subject to re-examination (Marconi & Lakatos, 2003; Martins & Theóphilo, 2009). While the semi-structured interview, according to Silva and Russo (2019), allows an interaction between interviewer and interviewee, through a previously prepared script, and may during conversation add new questions that drive the proposed study.

Finally, to validate the data collected was adopted data triangulation. According to Yin (2015), the triangulation of information in a case study can be used as research validation strategy and allows researchers to gain more in-depth insight into the study, the emergence of the facts and the possible actions of those involved in the research scenario (Souza & Zioni, 2003).

3.1 Study design

To answer the following research question "How knowledge capture model based on lessons learned can help in the estimation process on software projects?", A systematic

literature review was conducted. We used the academic databases Web of Science (WoS) and Scopus because of its relevance, the prominence they have, and the possibility to analyzed and systematize the research results.

For the systematic literature review process were employed the following keywords "(Project* Managem*) AND (Lesson* Learn*) AND (Software)". The words used were adding an asterisk (*) at the end of the terms to extend the results to be analyzed. The first survey was conducted in the WoS database using the filters "document types: (Articles)" and "categories: (computer science software engineering or computer science information systems or computer science theory methods or computer science interdisciplinary applications or management or computer science artificial intelligence or information science, library science or business) ", and returned 82 articles. While research in the Scopus database, applying filters "document types: (Articles)" and "subject area: (computer science or social science or business, Management and Accounting) "170 returned items. Finally, consolidating both results.

After the join results, the existence of duplicate articles was analyzed, and 52 were discarded, leaving 118 items. The following titles were analyzed, the abstract, and a thorough reading, those with a model of lessons learned for software projects were considered as inclusion criteria.

Thus, only seven items were considered adequate for the proposed study. These are the models proposed by: Abdellatif, Capretz and Ho (2019), Tahir et al. (2018), Guzman et al. (2013), Casey and Richardson (2009), Andrade et al. (2013), Papatheocharous et al. (2017) and Maturro and Silva (2010).

3.2 Analysis unit

The unit of analysis is a company that operates in Brazil, Peru, Chile, Argentina, and Mexico, with headquarters in Spain. The company is the Brazilian market leader in Business Process Outsourcing solutions (BPO) and Customer Relationship Management (CRM). It is considered the leading supplier of services and networking solutions with the customer in Latin America and is among the five largest companies in the industry worldwide.

It is an innovative company in their solutions, with a staff of 150,000 employees. The systems development area has an average of 150 annual software projects, composed of 39 analysts of various levels, with a portfolio of approximately 400 customers around the world. Concerning revenue, in 2018, the company reported revenue of 1.818 million dollars.

3.3 Data collection and analysis procedures

At this stage of the research, semi-structured interviews were conducted with managers and the company's project managers. Those involved have committed to the

activity estimation process in projects, participating from the initial estimate by the end of project execution.

The questionnaire presents issues that contributed to the data collection process to meet the research objectives. The questions were divided into two stages, the first part of the interview was applied to the questions that are related to capture and define the company's knowledge in relation to the activities of the estimate process. While the second part of the interview, questions were applied to identify how the storage process and dissemination of knowledge are acquired by completed projects.

A total of eleven questions were applied in six participants with roles of managers and individual forms of project managers, recorded, and transcribed. All participants have more than five years' experience in managing multiple projects, which allows us to analyze and highlight the necessary information for the development this research (Martins & Theóphilo, 2009).

After collecting the information and carrying out the transcripts of the interviews was used the Atlas.ti software for analysis and interpretation of the answers. The goal was to show a list of crucial information collected. Thus, were categorized data that expose the different views related to every aspect of search (Thiollent, 2009).

This process takes place in a nonlinear manner and seeking the best explanation for the phenomenon researched. It should be noted that tests were carried out in Atlas.ti software as analysis "co-occurrence" and analyzing "Codes-Primary Documents Table", these actions were taken to ensure the validity and reliability of the findings (Frieze, 2012). From the process of observation and analysis of documents, it was possible to identify, in the routine of respondents if they used the historical basis for projects such as knowledge base for the activity estimation process for new projects. It was also possible to observe the behavior of respondents when an estimate suffers change.

Regarding the documentary research, documents were found in the last three years with direct relation to the objective of this research. Documents store activities estimate information, historical-based projects, and lessons learned. The list of documents and the relationship with the search is shown in Figure 1.

Document	Relation to the survey
E-mail	<ul style="list-style-type: none"> • Activities estimate at any stage from the outside, except the planning phase. • Change requests estimates running activities. • Project history storage.
Internal system	<ul style="list-style-type: none"> • Activities estimate at the planning stage. • Schedule initial assembly.
Auxiliary documents (Word, Excel, and SharePoint)	<ul style="list-style-type: none"> • Activities estimate at any stage from the outside, except the planning phase. • Change requests estimates running activities. • Project history storage. • Process and transfer of knowledge in the team.
Shared network directories	<ul style="list-style-type: none"> • Notes exclusive designs by teams. • Projects history storage.

Figure 1. List of documents and the relationship to the survey
 Source: Prepared by the author based on the models found in the literature review

In response to documents, e-mails containing information from the planning stage to completion of the company's software projects, from initial estimates to the storage of project history. They were also subject to the internal system reports project control used by managers and project managers. The system is the official tool of the company to control and project management, containing information cost, time and effort required to carry out the project. Finally, we observed the unofficial repositories for storing information relating to the control and project changes. Documents were reviewed in the last 40 projects from each of the managers and project managers who participated in the interviews in this study. Unofficial repositories are used randomly between the teams and are divided into SharePoint, Excel spreadsheets, Word documents, shared network directories between the workgroup, and private notes of each manager and project manager. These repositories changes estimates are stored, the knowledge generated in the execution phase of the project, and lessons learned. This information is stored individually for each project manager.

4 RESULTS

In this section, the results involving the subject knowledge capture model based on lessons learned that could help in the process of estimates of activities based software projects will be presented on the data collected in the interviews.

4.1 Analysis of lessons learned models capture projects

The first result obtained in this study was through a systematic literature review and presented seven models that addressed the processes in software projects. After reading and detailed analysis of each model, it was given the pros and cons of each model for the specific purpose of this research, highlighted in Figure 2.

Authors	Synopsis	Features	
		Pros	Cons
Abdellatif, Capretz and Ho (2019)	Presents a model that provides solutions in the automatic search of the lessons learned more relevant in software projects, stored in a repository unstructured.	1 - Discusses the process of software development. 2 - Treatment of lessons learned automatically.	1 - Difficult to consolidate data from lessons learned. 2 - You can store information for undue be automatic.
Tahir et al. (2018)	Based on a systematic review of the literature (RSL) a success factors model was proposed to analyze the measurement practices extracted software organizations RSL.	1 - Discusses the process of software development. 2 - Based on measurement theory.	1 - Model tested only success factors - performance measures. 2 - There are tests to demonstrate the effectiveness of the model lessons learned.
Guzman et al. (2013)	It is presented a model using knowledge management strategies to achieve improvements in the software development process.	1 - Discusses the process of software development.	1 - Conceptual model only, not validated by a case study.
Casey and Richardson (2009)	Based on the identification of 10 key factors, one implementation model was developed to provide a practical and systematic approach to procedures for software development projects.	1 - Discusses the process of software development.	1 - Conceptual model only. 2 - Model does not cover the entire flow of information generated by the process of lessons learned.
Andrade et al. (2013)	A model based on lessons learned was proposed to perform software testing.	1 - Discusses the process of software development.	1 - applied only in software testing. 2 - The lessons learned from information other phases are discarded.
Papathocharous et al. (2017)	The proposed model provides a beginning, a post-planning, post-specifications, and a post-design estimate while using industry data.	1 - Discusses the process of software development.	1 - Conceptual model only, not validated by a case study.
Matturro and Silva (2010)	Presents a model to capture and manage software using knowledge and experience.	1 - Discusses the process of software development. 2 - Plan to the knowledge to be gained at all stages of the model. 3 - Information stored in a single repository. 4 - Information is enhanced in each execution cycle. 5 - After the execution is shared lessons learned with software practices and processes in use and activity of software projects.	1 - Model needs to be evaluated in software development environments distributed.

Figure 2. Pros and Cons of each capture lessons learned in model projects
Source: Prepared by the author based on the models found in the literature review

Analyzing the characteristics of each model shown in Figure 2, it was possible to highlight the behavior of each model in relation to the objective of this research. The model

proposed by the authors Casey and Richardson (2009), Guzman et al. (2013), and Papatheocharous et al. (2017) are models of conceptual design, not validated by a case study or other research. The model presented by the authors Andrade et al. (2013) applied only processes related to the objective of this research in the testing phase, discarding the lessons learned from other stages of the project. Already the authors Thair et al. (2018) tested the model only for project success factors using performance measures, distancing the objective of this research. The authors Abdellatif, Capretz, and Ho (2019) described a model that offers project managers an automation in the search for publications learned in an unstructured repository, but without the premise of supporting the process of evaluating future projects.

In contrast, Matturo and Silva (2010) present a model that addresses the software development process, as well as capture the knowledge gained in all phases of the project, including the control and management estimates, storing the information in a single repository. Because of having more adherent factors in this research, such as the use of a centralized historical basis and lessons learned, the model proposed by Matturo and Silva (2010) was adopted for the study of the case of this research.

The model presented by the authors is intended to manage the knowledge and experience gained by the team members, during all stages of development of software projects. The model identifies and captures the experience and knowledge acquired during the project activities to get the best practices by storing them as lessons learned. Finally, the model provides for the organization of management activities as part of their projects, providing specific guidance on how to build a database with the generated knowledge. This process occurs through the captured information by offering methods that are necessary to make sure that the lessons learned are used in process improvement in new projects.

4.2 Analysis and discussion of the interviews

With the results of the interviews, it was possible to point out the company's project management practices, highlighting the procedures related to the activities of estimates and compare the behavior of the model proposed by Matturo and Silva (2010). Thus, it was possible to note that the estimates of the activities of internal software projects do not have a standard method or project management technique used by the company object of this study. Some managers end up using techniques of agile estimates as "Planning Poker" and "Sprint Planning", while other managers use the experience of employees, historical projects, or similar projects. Regarding the implementation of projects by contractors, the company does not know what method or technique is employed to carry out the estimates.

During the interviews, they were presented several difficulties for the preparation of the estimate of the project activities, which could be verified in the speeches of E1 respondents "The main problem is the scope for often is not clear and definite. Therefore,

[...] bring the team that estimates so that they can understand the real need and are able to realize the estimated appropriately. "; E2 "[...] new processes become a problem due to lack of input to meet the new request." E5 and "[...] commercial area, which conducts negotiations with clients, [...] not having the knowledge that the project team has in relation to the required deployment time to meet customer needs, and begins to promise things to the customer, where the project team has to turn around to meet. ".

The interviews also showed that control versus planned activities is rarely applied. According to the E4 interviewed: "In the general context of the organization does not have a control of the estimates planned versus realized. [...] some teams end up doing it. But [...] in different projects with highest high complexity. A material is prepared [...] and disseminated what was estimated and realized the difficulties to be used as a reference in other projects of the same scale. ".

By analyzing the materials submitted by respondents to estimate the hours through internal tools (SharePoint, shared folders on the network) and documentation (spreadsheets in Excel, Word, and e-mails), it was possible to identify these practices, when used, they are analyzing the total project execution time, not separated by activities. This scenario confirms the reality of practices of company's project estimates, as evidenced in the speech of E1 interviewed: "If I estimated 100 hours for a demand, so I'm following the consumption of 100 hours if they are compatible or not."

In this sense, when the activity is poorly estimated or made without the use of a technique, problems such as lack of resources, project review, and time are recurrent in project execution. These occurrences, according to the respondent E1, "are usually recorded at the end of consumption of the total hours of the project, it is challenging to see what missing hours in the case of the effort of each human resource is, not in the activity duration. It is more difficult to control the duration and time of each task because during the execution of the project has a delivery forecast of each activity, which when added up, it is possible to follow the entire duration of the project. "

It was observed that there is no pattern to make estimates of new project activities. Each manager or manager responsible for the project has its technical estimates. The same scenario occurs when estimates change during the life cycle of projects. In some cases, changing the estimate was requested informally to the manager or project manager who accepted the request. However, it was not registered in any of the storage medium change information, contributing to the loss of historical data of projects, and in the future, to the process of lessons learned.

Concerning to management practices, the company, to improve their processes, used the experience of professionals based on historical results, and determined an average of seven days to teams deliver estimates of activities of new projects. However, we found that average hours showed oscillation during interviews. While the respondents E1, E3, E4

and E6, 7 days confirmed by now established as a standard, E2 interviewee reported that takes about 5 days to 2 hours to estimate projects agile.

Another point made during the interviews is the means that the organization invests to gain knowledge about the projects. Respondents pointed out that some areas of the organization conduct internal training for new knowledge but restricted by staff. This practice uses the experience of professionals to share knowledge acquired in projects with other team members. When you do not have the expertise to the execution of a given project, in some situations, the company conducts workshops, lectures, and courses with partner institutions, where the purpose and train professionals in new knowledge for implementation of new projects.

In addition to these trainings, the company employs internal tools and auxiliary documents to provide the sharing of knowledge and experience of professionals. The company could be identified that the process of knowledge sharing among project teams is hard to do because of the company culture and the ongoing prioritization of projects. This reality is evident in the speech of E4 interviewed: "The process is carried out only by some teams. There is no organized movement within the company that makes this dissemination of knowledge to equalize all project teams. For just depending largely on the initiative of professionals [...] ". Despite this the E4 testimony, other respondents reported that keep the share, either through documents or mainly by dialogue,

Speaking still of knowledge, respondents reported that during the project life cycle, catch up new knowledge, especially in developing the scope of projects. According to the E1 interviewed, "at the time of drafting the scope, I seek to build the team with professionals who have the know-how of the project scope. However, when you do not professionals, they are able to get the experience required for the execution of the project. " The respondent E2, and condone the E1 interviewed, presents an example of how to capture new knowledge is accomplished: "Imagine that I am preparing a study, [...] seek a knowledge that I do not have to meet [...] I am beginning to think, if other requests have equal, or whether it makes sense to put inside my solution [...] and improve the development,

During the interviews, participants mentioned a lot about tools that the organization uses to carry out the control of the projects. When asked to respondents what kind of tool the organization uses to manage lessons learned, some respondents had tools like SharePoint, folders on networks, documentation such as Excel spreadsheets and emails.

Regarding lessons learned, the dialogue was the practice highlighted by managers and project managers, reinforced by the statements of the respondents E1 "Internal system, SharePoint, shared network area. But what is used is the talk (corridor) [...]", and E3" What is more useful to exchange project information is the daily dialogue. ". But when you can store the lessons learned, the data end up losing,

With the interviews, it was possible to note the adoption of traditional and agile management practices in the studied company projects, including for the development of activities of estimates. As stress Tan, Yap & Yap (2012), these methods help the project manager to plan and execute the duration of each project activity. However, we can say that the lack of an expert to validate the estimates is presented in the words of the interviewees. In this sense it is confirmed that describe Yousef, Alshaer and Alhammad (2017), that the inappropriate choice of a method or technique can estimate excessively the use of labor, increasing the cost of unacceptable form of design, or scarce, overloading the staff and hindering the development of the project.

In this case, we use the experience of professionals to establish an average of 7 working days to prepare the estimates that did not work for all project teams. This confirms the prescribing Kerzner (2009) and Tereso et al. (2019), when the authors say that the application of good practice requires an evaluation by organizations because its use may not have the same effect achieved by another organization. Moreover, the lack of some professional initiatives, and even the company's culture not to prioritize certain processes, such as capturing lessons learned, creates difficulties in capturing the required information for the preparation of project execution stages. However, when is the use of good practice in project management, implementation of project activities is fulfilled effectively and efficiently (PMI, 2017).

Finally, it was evident that the studied company uses an internal tool that allows control of hours planned versus realized, however, the tool is limited to only control the total duration of the project. When you have a tool that allows performing a control more detailed, for example, the duration of activity, the information can be used in any type of project and in different sectors and organizations in order to achieve better control and use of existing resources as: materials, equipment, costs and even team members who use working time in activities (Cho, 2006).

4.3 Validation of Matturo and Silva Model (2010)

From the analysis of the results obtained through interviews and observation of documents, it was possible to present in Figure 3, the pros and cons aspects of the preparation of estimates practices in activities based on lessons learned from the object research company in relation to the model proposed by Matturo and Silva (2010).

Phase	Approach	Company practices versus Model	
		Pros	Cons
Capture and define the knowledge and experience.	Prepare the organization for a sequence of processes, to capture knowledge and experiences.	Use methods of traditional and agile estimates.	Estimation of activities does not provide a validation specialist.
		Use the day to day dialogue.	Difficulty in capturing the information needed to prepare the project execution stages.
		Groups of people for proactive dissemination of knowledge.	Lack of initiatives by professionals to standardize enforcement procedures. Organizational culture.
		There are internal tools for project control.	Only store information of complex projects.
		There is control versus planned hours performed.	Estimates are not made by tasks, projects only.
		an estimated average was established for all project teams.	The average preparation of estimates is made by professional experience.
Develop reflective tabs	Present team members questions raised by capturing the knowledge and experience so that individuals can analyze the activities that will be developed in the project. The activities of the project, the project team begins to outline proposals for improvements that will be analyzed and discussed later in planning phase.	knowledge sharing initiatives.	There is a practice applied throughout the organization.
Initial capture new knowledge and experience.	That time is analyzed the collected responses in reflective tabs and synthesizes the knowledge and experiences acquired, to identify and extract lessons learned from the implementation of the project tasks.	Capture new knowledge during the project life cycle.	Knowledge generated is not always stored.
Develop lessons learned and best practices.	Identifies lessons learned in line with certain goals in Phase 1 of the model.	Standardized in the project planning phase.	Do not use storage tools, prefer to share the information using the dialogue daily.
Repository of lessons learned and best practices.	Stores lessons learned and best practices of knowledge and experience captured in the previous phase, including new knowledge and experiences and reformulates existing.	Internal use software, SharePoint, shared network folders and documents (Excel, Word, and e-mails).	Not all project teams store the information on the tools and when store is hard to see.

Figure 3. Results of interviews in relation to the model proposed by Maturro and Silva (2010)
Source: Prepared by the author based on the search result

On the information presented in Figure 3, the model proposed by Maturro and Silva (2010) can prepare the organization for a sequence of processes, in order to capture knowledge and experience through the lessons just learned in the project planning phase. It may be noted that knowledge sharing initiatives are carried out, even if it is not a practice applied by all the teams of the company. Therefore, when the organization can share knowledge with other individuals but also claim McClory, Read and Labib (2017), the knowledge gained is able to reduce risk and increase efficiency, even at times appear

obstacles in the capture and in use. In this sense, the model of Matturo and Silva (2010) can contribute to knowledge sharing, presenting to team members information gathered by capturing the knowledge and experience. The purpose is to allow team members to analyze the estimates of the activities that will be developed in the project. In parallel, the project team can begin to outline the proposals for improvements that will be analyzed and discussed later in the survey phase requirements.

Another favorable aspect that showed no negatives in this study was the capture of new knowledge, which takes place throughout the project life cycle. According to Bjorvatn and Wold (2018), the presence of knowledge is crucial in the integration of the project life cycle, because the learning that is generated during execution. This learning makes the organization to achieve their professional contribution to the sharing of their knowledge through communication or writing (King Jr & Marks, 2008). With the Matturo and Silva (2010) model this information can be analyzed and synthesized, where the intention is to identify, and extract lessons learned during the implementation of project activities.

According to Winter and Keys (2017), projects must obtain a structure that stores their plans, budgets, reports, and lessons learned, so you can better share their knowledge, contribute to the increase of project members' skills. In contrast, the negative aspect, it was evident the fact that the company does not adopt a centralized tool storage of historical project information. The company currently uses internal software, SharePoint, shared folders on the network, Excel, and Word documents, emails, and own control of each manager or manager. This practice creates many problems in project design as possible cost increases, extended schedules, communication problems between staff and others involved in the project, rework and susceptible to failures environment (Jugdev, 2012). Thus, based on the results observed during this study, it can be said that the model proposed by Matturo and Silva (2010) may to manage knowledge of the project, allowing the possibility of using the knowledge from previous projects to produce and improve results, supporting the operations of the project and future phases.

In this sense, not all project teams store the information on the tools, and when stored came from the information of complex projects that are likely to be replicated in new projects. The data that is stored is difficult to use because the information from the lessons learned is not centralized. However, access to such information is ultimately restricted only to the staff member himself who created it. Thus, by adopting the model proposed by Matturo and Silva (2010) it is possible to develop processes that allow you to store centrally lessons learned and best practices of knowledge and experience, captured throughout the project life cycle. It is noteworthy that this information will be stored and available to the entire project team.

It is worth noting that organizations are adopting lessons learned as methods or models to support their managerial practices, to improve project management processes,

increase performance search in project development (Santos, 2014). The lessons learned are intended to gather information on the extracted results in completed projects and offer solutions for better performance in future projects (Chaves et al., 2016).

5 CONCLUSION

This study aimed to propose the use of a knowledge capture model for software projects based on lessons learned. For this study, we adopted the qualitative approach with descriptive perspective analysis, applying a single case study strategy, where the object of study company did not have his name disclosed for data security and confidentiality reasons previously agreed between interviewer and company.

To achieve the goal was made a systematic literature review to search a model that captures knowledge in software projects based on lessons learned. The model found is presented by Matturo and Silva (2010) model. Data collection was made through semi-structured interviews, and document analysis. Interviews were conducted with managers and project managers directly involved in the development of activities estimates process in projects. The document analysis was restricted to internal company documents to control and project management selected materials because of the confidentiality of the information, and the use with the concern higher hierarchical levels.

At first, this study answers to your research question, of how to use knowledge capture model based on lessons learned can contribute to the process activities estimates on software projects, not only for projects with traditional approaches management but also for agile approaches projects. Based on discussions made between what was observed in literature and field research, it can be understood that the object of this case study does not have a process model defined in relation to the generation of knowledge and lessons learned. The research showed that this situation occurs because of the existence of cultural problems, the high volume of projects, and the constant re-prioritization of the company's projects. This result is consistent with what has been shown in the literature, where several models that allow organizations to structure their tasks routines, and to benefit from the results achieved during the life cycle of projects, and generate knowledge and lessons effectively learned used (King & Marks Jr., 2008; Brusamolín & Moresi, 2008; PMI 2017).

In a second step, to identify the main difficulties about how company fails, to establish the duration estimation process activities effectively and efficiently, interviews were conducted with managers and project managers. One of the main difficulties pointed out, was the lack of process in relation to the storage of centralized knowledge gained from projects undertaken. This scenario directly interferes throughout the project development process, where knowledge ends up getting lost along the project life cycle or limited to the tacit knowledge of a single resource (Tastekin, Erten & Bilgen, 2016). In this sense, the model proposed by Matturo and Silva (2010) may help to minimize these impacts by

centralizing the storage of knowledge and lessons learned during all phases of the projects. This model can serve as a support tool for managers and managers in the planning process and in the monitoring and control of project activities estimates.

Another limiting factor is presented in relation to the storage of information lessons learned. The results showed that each team stores the lessons learned in different repositories such as Excel spreadsheets, SharePoint, Word, and e-mail. This practice makes it difficult for the lessons learned generated knowledge by the completed projects, to be used as a source of research in the process of new project activities estimates. The fact that the company has multiple repositories for historical storage of estimates of activities results in loss of consciousness and difficulty without using the lessons learned. Thus, the model of Matturro and Silva (2010) can be adopted as a strategic tool to use this information to support the estimates of new project activities.

Given this situation, it is understood the organization's negligence in not giving due importance on information that is generated during the lifecycle of a project, it was proposed knowledge capture model for software projects based on lessons learned - model proposed by Matturro and Silva (2010). The model allows the company to obtain new knowledge, or to consult the existing knowledge throughout the project life cycle, and support managers and managers in the process of developing the activities of estimates more accurately, using as support information lessons learned acquired in completed projects.

At the end of this research, it can be said that the objectives were achieved since it was identified and understood that the model proposed by Matturro and Silva (2010) can contribute from the capture lessons learned, and became more efficient processes in the process of estimates new project activities.

The study was limited only in the research and analysis of a proposed model to capture knowledge in software projects based on lessons learned to a specific organization. Thus, the implementation of the recommendations and contributions proposed in this study will be for a future study.

Regarding the respondents, although major theme specialists of this research and the interviews have been satisfactory to evaluate and answer the questions posed in the study, some organizations had little time revealing a limitation with respect to the organization's processes. Another limitation of this study refers to the use of a single case study as a research strategy. Even the company be characterized in large and with operations in several countries, the results cannot be generalized, as companies have different cultures and processes in relation to the storage of knowledge and lessons learned.

Finally, the small amount of information, obtained during the interviews and document analysis, are also considered limiting factors of this research, not allowing the

researcher to take advantage of new generation scenarios of knowledge and learned and review lessons with more comprehensive use of this information on the activities of the estimate process.

To carry out further work, it is suggested the deepening of the results in a larger number of companies, in order to validate the use of the model proposed by Matturro and Silva (2010) as a tool to support the activities of estimates process new projects. Another suggestion is to replicate this study in companies with planning oriented projects (waterfall) and agile approach since it was not found any knowledge capture model and lessons learned in the literature.

As the study was to propose the knowledge capture model for software projects based on lessons learned, it is suggested for future research develop a framework for use as new projects estimates support tool and also to change estimates during the cycle lives of projects, both traditional approach projects as agile approach projects.

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