A PROPOSAL TO MANAGE LESSONS LEARNED IN PROJECTS: WEB 2.0 TECHNOLOGIES TO PROMOTE INNOVATION

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ABSTRACT

The web 2.0 is transforming the project management in organizations by improving communication and collaboration. The new generation of web-based collaborative tools provides much better experience than the traditional software package allowing document sharing, integrated task tracking, enforcing team processes and agile planning. Despite of the indubitable benefits brought by web 2.0, the use of these technologies to promote knowledge management remains unexplored. For many project managers to obtain and integrate information from different tools of previous similar projects in global organizations remains a challenge. This theoretical paper presents a proposal that suggests an innovation in the knowledge management area applying web 2.0 technologies. The main goal is to provide an integrated vision of a set of technologies that could be used by organizations in order to promote better management of lessons learned. The proposal includes the lessons learned processes (e.g. capture, share and dissemination), the process-based (e.g. project review and after action review) and documentation-based (e.g. micro article and learning histories) methods. Results show how web 2.0 technologies can help project managers and team project to cope with the main lessons learned processes and methods to learn from experience. Moreover, recommendations are made for the effective use of web 2.0 components promoting innovation and supporting lessons learned management in projects.

Key-words: Project Management; Lessons Learned Processes; Lessons Learned Methods; Project Learning; Web 2.0 Technologies; Innovation.

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1   INTRODUCTION

Innovation generally refers to the use of a novel idea or method in order to renew, change or create more effective processes and products. Inside of this context, this paper proposes an innovation in the knowledge management area applying the use of web 2.0 technologies to promote an effective managing process of lessons learned providing an ideal environment to project teams learn from the experience. Lessons learned (LL) is a well-known project management tool and can be defined as the learning gained during the process of performing a project. This learning should be applied on future projects to promote the recurrence of desirable outcomes and to avoid or mitigate possible problems.

One of the main challenges that organizations have faced is little incentive or structure for long-term organizational learning (Hobday, 2000). Although systematic project learning enables an enterprise to develop project competencies that lead to a sustainable competitive advantage, organizations have failed in provide an environment to promote the use of lessons learned. Researches in Project Management (PM) have highlighted the relevance of lessons learned to support and improve results of current and further projects (Weber, Aha, & Becerra-Fernandez, 2001; Schindler & Eppler, 2003; Petter & Vaishnavi, 2008; Williams, 2008; Jugdev, 2012, Veronese, 2014). Moreover, LL are relevant because they can provide insights on both the decisions taken regarding communications issues and the results of these decisions in previous similar projects.

Although LL to be theoretically important, in practice LL are a complex issue that evolve people, processes, activities and technologies. Moreover, LL are present in all phases of a project as well as they make part of the contextual, behavioral and technical competences. Probably because of this complexity, LL

have received little attention from PM researchers. In a review of PM literature, Jugdev (2012) verified that the topic of LL has yet to gain more prominence.

One of the main difficulties of project managers is to manage LL during the project. While 62.4% of organizations have formal procedures to document LL, 89.3% of organizations are not doing it (Williams, 2008). Schindler & Eppler (2003) found that the main causes of the lack of documentation of LL on projects are time, motivation, discipline and skills.

Although LL are often used throughout a project, few collaborators seem to be willing to share their knowledge. Petter & Vaishnavi (2008) found that 64% of participants in an experiment reported having learned from the documents filed by his peers. However, only nine percent were willing to contribute to the documentation due to the time and level of effort required. To minimize the time and effort, web 2.0 tools technologies (e.g. wikis, blogs and microblogs) can be an alternative to be explored, considering the high investment by companies in the last years. According to (Singer, 2008) companies would have spent $4.6 billion by 2013 to integrate web 2.0 technologies into their corporate computing environment.

Emerging web 2.0 technologies and applications start to gain visibility and use by project managers to better support daily tasks and processes (Boulos, Maramba, & Wheeler, 2006; Cleveland, 2012; Grace, 2009; Shang, Li, Wu, & Hou, 2011). Gholami & Murugesan (2011) detail how the managers of global IT projects are using web 2.0 technologies to support everyday tasks and thus improve the management of a project as a whole. (Chi, 2008) also describes as project managers are using web 2.0 technologies such as blogs and Rich Site Summary (RSS).

Despite the use of web 2.0 technologies be broad in PM (e.g. creation of

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deliverables, status reports, "great ideas" saved for later, standards and practices), this paper focuses on their use to cope with LL. Web 2.0 technologies need to be better grasped to store, capture, share and disseminate LL in a project.

Although some projects successfully deal with LL, this subject remains being an appellant challenge to project managers, since as (Polanyi, 1966) stated "we can know more than we can tell." Tacit knowledge is implicit in the expression "know more", and consequently is more difficult to operationalize. One of the issues approached in this paper is to provide facilities to capture LL from the project team.

The aim of this study is to present a proposal for using web 2.0 technologies to

support LL in PM. Instead of using commercial and legacy LL systems such those listed by (Weber et al., 2001), free web 2.0 technologies can provide a simple, easy and more efficient way to deal with LL. Despite the theme of LL involve human and technological issues; this paper focuses on technological issues.

This paper is structured as follows: Section 2 describes the theoretical background, which involves LL process and methods, and the main web 2.0 technologies. Section 3 details the proposal to manage LL through web 2.0 technologies. Section 4 presents a discussion on the main topics of this paper, concludes the paper and outlines further works.

2 THEORETICAL LITERATURE REVIEW

2.1 Lessons Learned

Senge (1991, p.8) describes learning organizations as "organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together". LL are an intrinsic part of learning organizations. Project Management Institute (2013) defines LL as the knowledge gained during a project which shows how project events were addressed or should be addressed in the future with the purpose of improving further performance.

Although the literature is rich in the definitions of LL, this paper adopts the one proposed by Secchi, Ciaschi, & Spence (1999). "A lesson learned is a knowledge or understanding gained by experience. The experience may be positive, as in a successful test or mission, or negative, as in a mishap or failure. Successes are also considered sources of LL. A lesson must be significant in that it has a real or assumed impact on operations; valid in

that is factually and technically correct; and applicable in that it identifies a specific design, process, or decision that reduces or eliminates the potential for failures and mishaps, or reinforces a positive result." Lessons learned can be categorized as follows (Weber et al., 2001):

- **Informational** (e.g. how employee's duties could be changed during times of emergencies);
- **Successful** (e.g. capture effective responses to a crisis);
- **Problem** (i.e. describe examples of actions that failed and potential ways to resolve them).

However, Weber et al. (2001) suggest categorizing lessons by their contribution rather than, or at least in addition to, the type of experience from which they were derived (e.g., success or failure).

2.1.1 Lessons Learned Processes

The literature on learning organization has described a set of LL processes named as follows: collect, capture, gather, verify,

store, share, distribute, disseminate, reuse,

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and apply. Weber et al. (2001) propose four LL processes: collect, verify, store, and disseminate. They also highlight the sub-processes into each of process proposed by them.

Five sub-processes compose the collection process: passive collection, reactive collection, after action collection, proactive collection and active collection. Passive collection occurs when organizational members submit their own lessons using a form (e.g. online). In reactive collection, members are interviewed to collect lesson. After action collection is accomplished during or near the completion of a project. In proactive collection, lessons are captured while problems are solved. Active collection can be carried out through two ways: 1) Active scan attempts to find lessons in documents and in communications among organization's members. 2) Problems demanding lessons are identified and a collection event is planned to obtain relevant lessons.

The process of verification focuses on validating LL for correctness, consistency, redundancy, and relevance. The store process addresses issues related to the representation (e.g., level of abstraction) and indexing of lessons, formatting, and the repository's framework. Lesson representations can be structured, semi-structured, or in different media (e.g., text, video, audio) (Weber et al., 2001).

The process of dissemination is also decomposed into five sub-processes: Passive dissemination, which users search for lessons in a (usually) standalone retrieval tool. In active casting lessons are broadcast to potential users via a dedicated list server. Broadcasting uses bulletins are sent to everybody in the organization, as is made in some LL organizations. In the active dissemination sub-process users are dynamically notified of relevant lessons in the context of their decision-making process. In the proactive dissemination sub-process the system builds a model of the user's interface events to predict when

to prompt users with relevant lessons.

Finally, the reactive dissemination occurs when users realize they need additional knowledge, they can invoke a help system to obtain relevant lessons and related information (Weber et al., 2001).

This paper summarizes the essential processes to simplify the management of LL, which are described in the following.

- **Capture**: The process of bringing together information or knowledge from different sources has been indistinctly denominated gather and collect in the PM literature. In this paper the process of capture includes to gather and collect LL.

According to Hornby & Turnbull (2010), to gather means to bring together information which are spread around within a short distance. Hornby & Turnbull (2010) also defines the verb to collect as to get examples of something from different people or places that are physically separated. To capture is defined by the same dictionary as to represent or record in lasting form. In a PM perspective, the capture of LL includes information spread around within a short distance and people physically separated. Lessons learned can be captured through text, audio, video or image.

- **Storage:** The storage process searches to define the environment where LL will be stored. It should consider a range of formats to allow the capture process to collect talks (audio and video), technical procedures (image and video), and formal and informal documentation (text).
- **Share and Verify**: Share LL means to make them available at the same time for a team of experts who, according to (Weber et al., 2001), focuses on validating them for correctness, consistency, redundancy, and relevance. Moreover, each lesson need to meet the criteria proposed by

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Secchi, Ciaschi, & Spence (1999): to be significant, valid and applicable.

- **Distribute or Disseminate**: To spread the knowledge contained in the LL by a team, department or organization.
- **Apply or Reuse**: To make useful the LL on current and further projects.
- **Withdraw**: To recognize when an LL is no longer useful on current and further projects.

2.1.2   Lessons Learned Methods

Lessons learned are relevant ways of gathering and sharing (Secchi et al., 1999) formal and informal project knowledge (Jugdev, 2012). Project learning has been captured and shared through structured project lessons (project reviews) and less structured Community of Practice (CoP). Both project reviews and CoP are methods organized in the scope of a set of processes.

Schindler & Eppler (2003) classify methods to foster learning in two groups. Process-based methods stress the relevant steps and their sequence in course of a project's time line while documentation-based methods focus on aspects of the content wise representation of the experiences and the storage of contents within the organization (Schindler & Eppler, 2003).

The four process-based methods are project review or project audit, after action review, post-control and post-project appraisal. Post-control is carried out exclusively at project's end and post-project appraisal is performed approximately two years after project completion.

Taking into account that project processes are generally temporary and unique, with nonroutine features, hindering learning, we should retain the knowledge generated along the project since the beginning. According to Bentley (2010)

the Lessons Learned Report is gradually built up (and acted on) during the project and handed over as one of the products at Project Closure. In this paper, I follow this recommendation and adopt the project review, after action review methods because they can be executed in the course of the project and during the work process. Moreover, web 2.0 technologies are available throughout the project not being necessary to wait the end of the project to start some process to deal with LL.

Project review or project audit can be characterized has follows: participants are project team and third parties that are involved into the project. Its purpose is status classification, early recognition of possible hazards, and it has also a team-internal focus. The main benefits include the improvement of team discipline, prevention of weak points and validation of strategies. The interaction mode is face-to-face meetings.

After action review has as participant the project team and its purpose are learning from mistakes and knowledge transfer inside the team. The main benefit is the immediate reflection of the own doings to improve future actions. The interaction mode is cooperative team meetings.

On the other hand, the documentation-based methods described by Schindler & Eppler (2003) are micro articles, learning histories and RECALL. A micro article is written in an informal style with a framework that consists of a topic, an introductory short description of its content and a keyword part for indexing the article (Schindler & Eppler, 2003).

Learning history is a written story consisting of the main events of a project arranged in a chronological order. Contrary to micro article that has at most one page, a story can contain between twenty and one hundred pages following a story-telling approach. Once compiled,

learning histories are validated in

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discussions with the people involved.

RECALL was a prototype used by National Aviation and Space Agency (NASA) where users could submit their LL directly using a Web browser. The lessons were directly inserted in a database. After the insertion, users were asked to answer a set of questions to the system to add relevant context information.

The most appropriated documentation-based methods described by Schindler & Eppler (2003) to use with web 2.0 technologies are micro articles and learning histories. RECALL was an example of prototype supported by a LL system and used internally at NASA, which makes difficulty to adapt to the reality of the most project-based organizations.

The last method to foster LL in this paper is journaling. According to Loo (2002) a journal is an articulated narrative that follows from the reflective and critical thinking about one's learning experiences or specific learning events. (Loo, 2002) presents a three-stage model of reflective learning, (1) awareness, the present situation, (2) critical analysis, which connects present with the past and future, and (3) learning, the development of a new perspective based upon one's critical analysis and the application of new knowledge to the learning situation under reflection. Loo (2002) also suggests a set of questions to help building a journal.

- What was the learning situation/event?
- What have I learned, and how did I learn it?
- How do I feel (good or bad feelings) about what I learned?
- How could I have learned more effectively/efficiently?
- What actions can I take to learn more effectively/efficiently in the future?
- In what ways do I need to change my attitudes, expectations, values, and the like to feel better about learning situations?

Lessons learned methods are plentiful in literature, as summarized in Table 1. In addition, Busby (1999) classifies post-project reviews into two types: chronological reviews and categorical reviews.

Table 1: Main lessons learned methods in the literature.

Lessons Learned Methods	Authors
Project Review	Schinder and Eppler (2003)
Postcontrol or Post-Project Review	Schinder and Eppler (2003)
After Action Review	Schinder and Eppler (2003)
Post-Project Appraisal (two years after project completion)	Gulliver (1987)
Journaling	Loo (2002)
Learning Histories	Roth and Kleiner (1998)
Micro article	Willke (1998)
Project history day	Collier, DeMarco and Fearey (1996)
Appreciative Lessons Learned Method (4ALL)	Baaz et al. (2010)
Retrospective Meetings	Derby, Larsen & Schwaber (2006)

Source: The authors.

2.2 Web 2.0 Technologies

Web 2.0 technologies have been used to

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support knowledge management, rapid application development, customer relationship management, collaboration and communication, training, and innovation (Andriole, 2010). Additionally, Glória Júnior, Oliveira and Chaves (2014) introduce a proposal for using web 2.0 technologies in agile methodologies such as SCRUM. In the same vein, according to the survey carried out by Andriole (2010), knowledge management, collaboration and communication are the areas which web 2.0 technologies contributed most.

As regards knowledge management, web 2.0 technologies have also the potential to complement, enhance, and add new collaborative dimensions to the processes of storing, capturing, sharing, disseminating and applying lessons learned. Web 2.0 technologies are characterized by ease of use and rapidity of deployment, making possible powerful information sharing and straightforward collaboration (Boulos et al., 2006). Further, these technologies afford the advantage of reducing the technical skill required to use their features, allowing users to focus on the exchange of lessons learned and collaborative tasks themselves without the distraction of a complex technological environment. Contrary to lessons learned repositories in off-the-self software, web 2.0 sites and applications provides simple and easy ways to store, capture, share and disseminate lessons learned. The main web 2.0 technologies to be applied to these tasks evolving lessons learned are described in the following.

2.2.1 Blogs

A blog is a discussion or informational site published on the Web and consisting of entries typically displayed in reverse chronological order. Most blogs are interactive (i.e. open to comments by visitors) and have a set of characteristics that allow them to gain popularity.

The technical and behavioral characteristics of project blogs are very lightweight, chronologically sequenced,

easily skimmed, and entries easily accessed (Grudin, 2006). In a survey of 212 blog participants, Hsu & Lin (2008) found that ease of use and enjoyment, and knowledge sharing (altruism and reputation) were positively related to attitude toward blogging.

Reverse blog, which is composed by a set of bloggers rather than a single blogger, is also useful in the context of a project. It allows the coworkers report the progress of the project for managers or clients and describes lessons learned.

2.2.2 Microblogging

Microblogging "allow[s] users to exchange small elements of content such as short sentences, individual images, or video links" (Kaplan & Haenlein, 2010). It is a broadcast medium in the form of blogging that allows users to write brief text updates (usually less than 200 characters) and publish them, either to be viewed by anyone or by a restricted group which can be chosen by the user. Notable active microblogging services are Twitter, Identi.ca, Tout and Yammer. Actually, in a typical day, Twitter has more than 500 million tweets sent a day which means about 5,700 tweets a second, on average (Twitter, 2013).

The simplicity and ability to post frequently seem to be what attract most to the concept. The characteristics also make the use of microblogs successful are a) the creation of ambient awareness; b) a unique form of push-push-pull communication; and c) the ability to serve as a platform for virtual exhibitionism and voyeurism (Kaplan & Haenlein, 2011). Creation of ambient awareness refers that in combination, different tweets sent out over time can paint a very accurate picture of a person's activities.

This feature allows project managers follow the progress of a team as well as the individual members.

Push-push-pull communication refers to

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the feature of one author's tweets are automatically pushed onto the Twitter main page of all followers. If the receiver of the message finds the news so interesting and intriguing that he decides to give it an additional push by re-tweeting it to their own followers. Once the message has been pushed and pushed again through the whole network, it may motivate some user to go out and 'pull' additional information on the subject from other sources. This feature makes it easy to augment the knowledge among the members of a project.

Lastly, the platform for virtual exhibitionism and voyeurism means "Twitter is like a huge one-way mirror which allows millions of people to sit on one side and watch the day-to-day lives of a select few who have decided to share their each and every move with the whole world." (Kaplan & Haenlein, 2011). Such a feature seems do not be applicable in the context of PM.

Literature is rich in examples of use of microblogs by organizations (Günther, Krasnova, Riehle, & Schoendienst, 2009). Directly related to the main topic of this paper, (Cleveland, 2012) proposes to evaluate the use of microblogs in the task of recording the lessons learned from the projects. He investigates if microblogging will be accepted and used for capturing lessons learned in projects, to what extension microblogging lessons result in knowledge reuse and how significant are the time savings for capturing microblogging lessons when compared to lessons captured via the traditional post-project review method. Considering that lessons learned are often informally reported microblogging has the potential to support this communication among coworkers.

2.2.3 Wikis

A wiki is a web application which allows people to edit content in collaboration with others. Beyond Wikipedia, another successful implementation of wikis is Wikidot (wikidot.com), a platform with more than 17 millions of pages and close to 1.3 million of people, which is also used to support group projects. Wikis have unique features such as collaborative authorship, instant publication, versioning and simplicity of authorship.

(Standing & Kiniti, 2011) stress the use of wikis for innovation, while (Parker & Chao, 2007) emphasize their use to enhance the learning process. (Grace, 2009) highlights other advantages in the usage of wikis, including ease of use, central repository for information, tracking and revision feature, collaboration among organizations and solve information overload by e-mail. She also lists the main existing types of wikis:

- **Personal Wiki** where user keeps it as a form of concept map or journal for an idea.

- **Semantic Wiki** where knowledge used is described in a formal term which allows for machine-processing like a semantic web.

- **Corporate Wiki** where it is mostly used internally in a corporate context contrary to public wiki on Internet.

- **Structured Wiki** combines benefits of sharing and collaboration of a plain wiki with structured elements of a database by allowing the structuring of information when needed.

- **Peer-to-peer Wiki** where wiki sites are shared between peers on a server-less system. It is stored on computers of the users and provides less security features.

Wikis allow implementing the process or task of socially constructed knowledge creation. In a PM perspective, personal,

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corporate and structured wikis can be implemented to support collaboration among coworkers. (Majchrzak, Wagner, & Yates, 2006) conducted a survey with 168 corporate wiki users. They found three main types of benefits from corporate wikis: enhanced reputation, work made easier, and helping the organization to improve its processes.

Finally, to choose a wiki platform, a project manager can take into account the wiki's selection and implementation framework proposed by (Grace, 2009). Moreover, a comparison among the existing wiki platforms can be made using the site Wikimatrix (www.wikimatrix.org). Wikis platforms usually contain a set of built-in or embedded web 2.0 technologies such as blogs, RSS, and tagging.

2.2.4   Other Web 2.0 Technologies

A social bookmarking service is a centralized online service which enables users to add, annotate, edit, and share bookmarks of web documents (Noll & Meinel, 2007). In the context of PM, the use of a platform of bookmarking (e.g. diggo.com) among members of a project is crucial to capture and share lessons learned from external environment. Technical problems are often discussed in specialized forums and blogs which store and describe a set of recurring problems and solutions. Once a project member find a useful lesson learned in a forum or blog, he/she can bookmark the web site or page and share it with co-workers. Moreover, the search process is facilitated by the use of tags. For instance, lessons learned about the planning phase of a project can be bookmarked with the tag "planning", which can help further searches about this topic.

Rich Site Summary (RSS) is a set of web feed formats used to publish frequently updated works such as wiki and blog entries, audio and video in a standardized format. Using this technology, project members can be automatically notified of updates in a wiki or a blog been used in a project, eliminating the need of periodic visits to search for updates in these sites.

Because of social networks (e.g. Facebook), VoIP (Voice over Internet Protocol - e.g. Skype) and Web-based Office Suite (e.g. googledrive.com) are considered the most popular web 2.0 technologies, this paper will not describe them.

Next section describes how to better leverage web 2.0 technologies and applications to improve the use of LL along a project. Associated with each process, we propose some lessons-learned methods using web 2.0 technologies.

3 A PROPOSAL FOR USING WEB 2.0 TECHNOLOGIES IN PROJECT MANAGEMENT

The web 2.0 is transforming the project management in a thousand of organizations by improving communication and collaboration. The new generation of web-based collaborative tools (e.g. application lifecycle management tools) provides much better experience than the traditional software package allowing document sharing, integrated task tracking, enforcing team processes and agile planning. Despite of the indubitable benefits brought by web 2.0, the use of these technologies to promote LL remains completely unexplored. For many project managers to obtain and integrate information from different tools of previous similar projects in global organizations remains a challenge.

The proposal introduced in this paper presents an overview of the most used web 2.0 technologies and apply them in the PM perspective. One of the objectives is to provide an integrated vision of a set of technologies that could be used by project members promoting the application and reuse of LL.

This proposal suggests an innovation in

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the knowledge management letting the project team collaborate and share information easily. Figure 1 outlines such vision.

In this proposal a wiki platform is used as a centralized repository of LL collected during the entire project life cycle. The centralized repository facilitates the access of all information related to the projects. The blog and RSS technologies are built-in or embedded in order to facilitate LL capture and dissemination respectively. In spite of providing a flexible structure and taking into account the different preferences of project members (e.g. one prefers use voice, other texts), this proposal presents a broad use of web 2.0 technologies. Orbiting around the wiki platform are the following technologies: microblogging, social bookmarking, social network, video, VoIP and web-based collaborative tools.

Due to the strong acceptance of internal and external social networks (Andriole, 2010; Moqbel, 2012), we propose that the organization or the knowledge management officer define and adopt a social network model in order to promote communication and dissemination. LL can be also shared by the team members through posts in microblogs using hashtags in order to facilitate information retrieval.

The wiki should present minimal structured information to identify the project and URLs of collaborators to allow that all members have access to the discussions posted in the social network.

Videos recorded in meetings or in the execution of technical procedures, relevant conversations carried out through VoIP and URLs of the documents in web-based collaborative tools should be also stored in the wiki. The flexibility provided by web 2.0 technologies allows integrating project information managed for different applications and media.

Figure 1: Using web 2.0 technologies in Project Management.
Source: The authors.

According to Jugdev (2012), to conduct an effective LL implementation is required management support, the right stakeholders should be involved and knowledge should be shared in both codified and uncodified ways. Therefore, we propose a semi-structured approach that better fit with the web 2.0 technologies. Based on the LL processes and methods described in the previous sections, Table 2 presents a proposal of use of web 2.0 technologies in order to support the LL processes in PM.

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Table 2: A proposal for using web 2.0 technologies to support the most relevant lessons learned processes.

Lessons learned processes	Type of data and Sub-processes	Web 2.0 technologies
Storage	Structured	--
	Semi-structured	Wiki, Web-based Collaborative tools
	Different media	VoIP and video
Capture	Passive collection	Wiki, Web-based Collaborative tools, blog, VoIP and video
	Reactive collection	VoIP and video
	After action collection	Wiki and Web-based Collaborative Suite
	Proactive collection	Wiki, Web-based Collaborative tools, VoIP and Video
Share and Verify	Passive share	Wiki, Web-based Collaborative Tools, Social Network and Social Bookmarking
	Active verification	Wiki, Web-based Collaborative tools
Disseminate	Passive dissemination	Wiki, Blog, Microblogging and social Network
	Active casting	RSS
	Broadcasting	Email
	Active dissemination	RSS
	Proactive dissemination	Social Bookmarking
	Reactive dissemination	Discussion Group

Source: The authors.

3.1 The Storage Process

The application of web 2.0 technologies in the LL context brings some interesting differences in the implementation of LL process. As presented in the previous sections to promote LL reuse the literature defines processes to collect, validate, store, and disseminate. Weber et al. (2001) propose to deal explicitly with storing after the verification process.

The proposal introduced in this paper argues that using web 2.0 technologies the LL storage process should be defined first. The project managers must to define which technologies will be used and how they will be integrated with each other in order to combine the technologies that better fit with the project´s features (e.g. projects related to user experience can disseminate more useful LL using videos).

Furthermore, define how the information will be stored is also a point of attention. Structured data requires the use of forms and metadata which makes the process slow and bureaucratic inhibiting the capture of LL. In our proposal lessons learned can be stored in text format or in different media. Therefore the semi-structured approach better fits to store LL using web 2.0 technologies. In order to facilitate the information retrieval some templates can be defined to present basic information about the project (name, project manager, scope, etc.) or LL in textual data (e.g. in question/answer or problem/solution format).

According to Figure 1, several tools are used to store LL and a wiki centralizes their contents through links to external sources such as documents in web-based collaborative tools, videos in video-sharing websites or web pages in social bookmarking web services.

3.2 The Capture Process

The process of capturing LL involves sub process, methods and technologies. The passive sub-process usually is performed through a set of forms in a legacy system. In our proposal the passive sub-process is carried out exploring the best features of the web 2.0 technologies such as collaborative authorship (wiki), speedy communication (microblog) and

easy integration (web-based collaborative tools, video, calls on VoIP). The most

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appropriated methods to perform passive collection are project review, retrospective meetings, learning history, micro article and journaling.

Interviews with project team members are used in order to cope with the reactive sub-process. To innovate, we propose that the results of this collection should be shared through videos becoming this LL capturing process more dynamic and attractive for the participants.

The after action sub-process is performed during the entire project's lifecycle conducive to the project´s team members review important events allowing them analyzing what and why happened and how to improve the results to execute the same, or similar, tasks. Therefore the suitable methods to perform this sub process are action review and retrospective meetings. Due to the features of this sub-process, the most appropriate technologies are Wiki and microblogs since they enable coworkers to capture lessons throughout the project.

The main goal of the proactive sub-process is share important events in the moment that they are happening (e.g. project member solving a problem). Microblog, Web-based Collaborative tools and videos can improve this LL capturing sub-process.

It is important to mention that methods to capture lessons can be carried out individually or in group. Micro article and journaling are individual methods to capture LL that can be supported by wikis or blogs. On the other hand, group methods including project review, after-action review and learning history can be performed using wikis or blogs. Project daily board can use blogs, specifically reverse blog. However, project managers should take into account that these methods can consume a lot of time of the project team members. We suggest increasing the periodicity of reports and posting only the relevant decisions or events (e.g. weekly dashboard).

Although the storage and capture processes are described in sequence, they occur almost simultaneously, once a project member report a lesson in this structure, the lesson is stored automatically. Finally, it is important to mention that more available methods and technologies, higher probability of lessons be captured by the project team members.

3.3 The Sharing and Verification Processes

The main goal of sharing and verifying processes is to validate the accuracy and applicability of submitted lessons. LL are submitted by team members in order to be validated by domain or subject matter experts. Due to the collaborative aspects provided by the web 2.0 technologies, the sharing and verification processes can be significantly improved. A team member that find a technical solution for a problem in a forum can easily share the URL of the web page using a social bookmarking tool.

Once the other members have access to this information, they can contribute criticizing or providing more details and posting this information, for instance, in the project´s wiki. This approach provides a first level verification which team members collaborating to improve the LL description becoming it more accurate.

The second verification level can be conducted by a set of subject matter experts in order to determine whether or not a lesson is pertinent for a particular project, department or can be applied to the organization as a whole. Once decided the relevance of the published information it can be highlighted in some specific communication channel(s) (e.g. intranet, internal social network and corporative wiki) in order to disseminate for a large number of people.

3.4 The Dissemination Process

The dissemination process allow users to retrieve information from past experiences on specific topics and directly communicate last verified lessons learned to various audiences. Passive

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dissemination can be performed using wiki platforms, blogs, microblogs and social networks. RSS is a useful tool to promote active casting dissemination. LL related to a specific topic are sent to an interested group of users (e.g. Project's members are only notified about the lessons relevant to their project´s tasks).

Broadcasting is carried out through bulletins which are sent to everybody in the organization using e-mail. Proactive dissemination can be partially performed using a bookmarking service through the automatic suggestion of tags when project members are tagging websites or web pages. Discussions group can be a useful tool to support reactive dissemination allowing the project team share project issues and obtain information from their partners. It is also interesting to observe that the traditional methods to capture LL do not refer (or explicitly mention) to the use of technologies as VoIP and videos. Table 1 showed that this tool should be considered while capturing LL.

Finally, some processes to deal with LL which involve the application, reuse and withdraw them are not being considered in this proposal once they are post-implementation processes.

3.5 Web 2.0 technologies-centered Lessons Learned Processes and Methods

Some of web 2.0 technologies described in this paper can be applied in other processes than those presented in the previous section. Microblogging could be used to share LL, but become more complex the first level of sharing and verification processes when project members need to augment its content. LL can also be captured through social networking; nevertheless, the verification process is remarkably complicated once

the subject matters experts need to check post by post. Moreover, in the social networks LL retrieval is more difficult when compared with other tools such wiki.

In this context, Figure 2 presents a web 2.0 technologies-centered perspective of the LL processes. It summarizes the most indicated technologies to be used with each process. Corporate Wikis appear as more comprehensive technologies to support the four main processes. Adjoining, wiki technology can easily integrate the huge amount of information provided by different web-based collaborative tools used during the project lifecycle.

Web-based collaborative tools and social bookmarking are also indicated to deal with storage, capture, share and verification processes. The dissemination process can be better performed using blogs, social networks, microblogging, RSS and e-mail than web-based collaborative tools or social bookmarking. VoIP and video are more suitable for the storage and capture processes. Blog is appropriate for capturing and disseminating LL, while social networking can be used to support the processes of sharing and disseminating.

Similarly to the processes, web 2.0 technologies can also support the LL methods. Figure 3 presents the web 2.0 technologies-centered LL methods. The corporate wiki, web-based collaborative office suite, VoIP and video, and blog technologies can be used to support process-based methods as project review and after action review. Journaling and micro articles can be done in a corporate wiki, web-based collaborative suite, or a blog. Wikis or web-based collaborative suites support longer texts, such as used in a learning history.
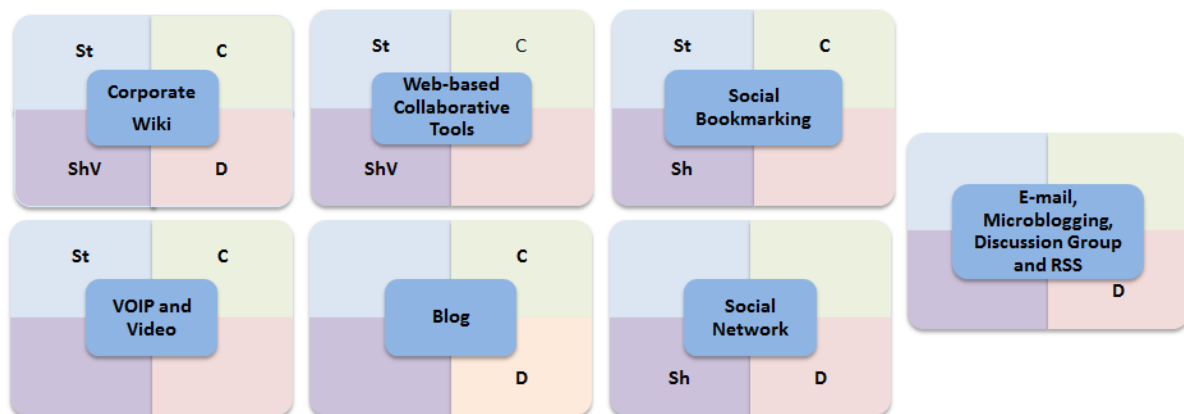
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Figure 2: Web 2.0 technologies-centered lessons learned processes. St: Storage, C: Capturing, Sh: Sharing, V: Verification and D: Dissemination.
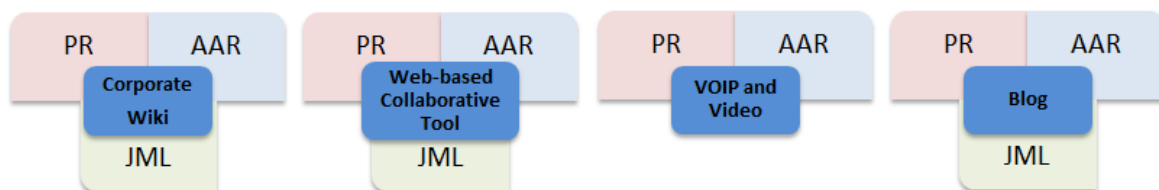**Source:** The authors

Figure 3: Web 2.0 technologies-centered lessons learned methods. PR: Project Review, AAR: After Action Review, JML: Journaling, Micro article and Learning history.
Source: The authors

Finally, this section presented an overview about how web 2.0 technologies can be used to support the management of LL in the PM perspective. Figures 2 and 3 illustrate that corporate wiki is the most complete tool to deal with LL processes and methods. In this sense, instead of introduce all technologies at the same time in a project, we suggest an adoption phased in order to verify which technologies can better fit with the project features and how they can be explored to promote LL. It can start with the implementation of a wiki and gradually accommodate other technologies considered relevant to the project. Technologies such as blog and RSS can be easily integrated in the project because they come built-in or embedded in the platform.

4 DISCUSSION AND CONCLUSION

The proposal introduced in this paper apply web 2.0 technologies to support processes and methods providing an effective LL management model. On the other hand, the use of these technologies release a set of issues which organizations, knowledge management officers and project managers should take into account in order to succeed in the implementation of LL processes. This section discusses some of these important points.

First, the implementation of a new technology in an organization is a challenging process. Standing & Kiniti (2011) list a set of challenges related to the use of wiki in organizations, which includes: management support, risk of vandalism and the uncertainty over quality control and evaluation, absence of organized culture of collaboration and knowledge sharing, failure to integrate the

wiki within established work practice, lack of clear guidelines and policies for wiki use, and wiki usability and accessibility. Organizations should take into account all these challenges before to implement wikis and other web 2.0 technologies.

As also noted by (Levy, 2009), organizations do not have the mass of people as Web does. Depending on the dimension of an organization, the maturity process of the technologies implemented can vary according to the number of users involved in the project. Moreover, it is relevant to motivate the users to share their knowledge.

One key issue to promote learning in organizations is the motivation of the stakeholders to share their knowledge with the pairs. However, Petter & Vaishenavi (2008) found that only nine percent of project members were willing to contribute to the documentation. Considering this, we strongly suggest organizations to create some kind of incentive to stimulate project members collaborate sharing to an effective implementation of the LL processes.

It is also important to mention the problem of "the obsession with tools and techniques" highlighted by Scarborough, Swan, & Preston (1999). They state that this obsession causes four problems: the assumption that all knowledge is codable, an overemphasis on new information technologies, an assumption that people are willing to share their knowledge and to use the knowledge from systems, and a rigidification of the informal and intuitive practices that are essential in a flexible firm.

As Williams (2003, p. 253) noted "projects are complex entities, and learning from complex systems needs a more sophisticated approach than simply writing down lessons". Web 2.0 technologies also allow dealing with LL throughout the project, instead of deal with LL only in the end of the project as in post-project evaluation reviews. This change in the management of LL will increase group communication taking project managers to identify new skills in the project members and to designate the role of communication leader to some of them. To coordinate the amount of information generated along the project is another critical factor of success in the implementation of web 2.0 technologies in project management.

Web 2.0 technologies have also a significant impact on the cost, duration and scope of a project. Instead of spend thousands of dollars in commercial LL applications, web 2.0 technologies provide an affordable solution to manage LL. Once that LL are applied and reused, the duration of activities is reduced releasing physical and human resources for other activities. Thinking about a set of activities where LL are applied, the scope of the project is positively changed. Moreover, the dynamic environment provided by web 2.0 technologies can help in the identification of leaders and promote innovation. The most active users of wikis, blogs and microblogs can be considered potential leaders in a team.

There is not a true one-size-fits-all approach that will result in effectively learning process. Based on their own culture, organizations need recognize the profile of their project members and features of their projects before define the appropriate tools to manage LL. Once the technologies implemented to support a project are well accepted, their use can be extended to support organizational learning process.

Finally, we have outlined how wider used web 2.0 technologies can effectively support LL processes in PM. These technologies facilitate the processes of capturing, sharing, storing, and allow LL to be widely disseminated by a team, department or organization. The proposal introduced in this paper is mainly based on both the LL processes described in Weber et al. (2001) and on the methods to learn from experiences introduced by Schindler & Eppler (2003).

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As future work, the proposal should be validated on project-based organizations using the action-research and case study research methods. Along this validation process, it will be possible to find the main limitations of the proposal as well as its extension with regards the processes, methods and the introduction of other web 2.0 technologies.

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