Identification of Effective Management Practices and Technologies for Lessons Learned Programs in the Construction Industry

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Abstract: Organizations in the construction industry cannot afford to make repetitive mistakes on major projects. Conversely, there are great benefits to repeating positive experiences from past projects. This need for institutional memory is amplified by the reality that in the course of normal turnover and retirement, people with years of experience leave their organizations. An effective lessons learned program is a critical element in the management of institutional knowledge; it will facilitate the continuous improvement of processes and procedures and provide a direct advantage in an even more competitive industry. This paper describes a research study that aimed to identify effective management practices and technologies for lessons learned programs in the construction industry. Data from 70 organizations that participated in this study are presented. Research found that even though more lessons learned programs are being initiated, the potential for savings and improvement has not been fully met. The study has also identified seven crucial characteristics of a successful program and verified that most organizations are stronger in some categories and weaker in others. The key to an effective program is to address all seven areas and guidance is provided for those wishing to implement lessons learned programs.

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Introduction

Many organizations in the construction industry have come to recognize the importance of a lessons learned program (LLP) as a vital asset that plays an essential role in knowledge management systems. In these organizations, project team members generally acquire new knowledge as their careers progress. This knowledge, which includes both successes that organizations want to repeat and problems they do not want repeated, may not be routinely disseminated throughout the organization. The value of optimizing the dissemination of this gained knowledge highlights the importance of LLP.

Optimally, organizations want a workforce evenly spread across age distribution to feed their workforce requirements. Unfortunately, this is not the case as the average age of the industry's workforce is high and rapidly approaching retirement (Gibson et al. 2003). Capturing, sharing, and utilizing the combined knowledge of the current workforce is essential so the industry and organizations avoid losing their vital, valuable asset—corporate knowledge.

Significant advancements in technology are allowing organizations in the construction industry to improve their collection, analysis, and implementation of LLP. Although many organizations have put LLP in place, they may not know how to evaluate the maturity and effectiveness of the program. In addition, legal aspects, measurement of value, and use of information technology (IT) resources are currently perceived by many organizations as areas of special consideration in the development and maintenance of a LLP.

The primary purpose of the study presented in this paper was to identify effective management practices and technologies for the development of a successful LLP. The first section presents a background on the subject of LLP. Next, the analysis of LLP through a multi-phased research effort is presented. Finally, implementation considerations, conclusions, and recommendations are addressed.

Background

The Construction Industry Institute (CII), a consortium of more than 110 leading owner, engineering-contractor, and supplier organizations from both the public and private sectors, defines the term "lesson learned" as the knowledge gained from experience, successful or otherwise, for the purpose of improving future performance (CII 1998; CII 2007a). Examples include:

- A lesson learned that is incorporated into a work process;
- A tip to enhance future performance;
- A solution to a problem or a preventative action;

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- A lesson that is incorporated into a policy or a guideline; or
- An adverse situation to avoid.

Harrison (2003) defines lessons learned as "a good work practice or innovative approach that is captured and shared to promote repeat application, or an adverse work practice or experience that is captured and shared to avoid recurrence." The European Space Agency (2006) describes it as "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 a source of lessons learned. A lesson must be significant in that it has a real or assumed impact on operations; valid in that it 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."

Some organizations believe that lessons learned must be incorporated into work processes, whereas others believe that a lesson is anything that will improve organizational performance. Therefore, it is important to adopt the definition that best fit the needs of each organization. No matter the specific definition used, lessons learned are always used to help an organization achieve its business needs and goals (Weber et al. 2001).

Lessons Learned Programs

A LLP consists of the people, processes, and tools that support the collection, analysis, and implementation of validated lessons learned in organizations. The ultimate goal of such a program is to add value to the organization by promoting the communication of information. The use of a LLP helps to implement knowledge management within the organization by collecting and disseminating information and experiences. People, processes, and technologies are crucial to the implementation of an effective LLP (Collision and Parcell 2005). People are the source of organizational knowledge, and their support and involvement in the program generate results. Processes and practices within the organization must be generated to allow for easy knowledge collection and sharing. Further, technologies must facilitate knowledge transfer between individuals. Emphasis on any one of these areas will cause the program to shift off-balance; therefore, organizations must strive to focus on all three areas equally.

Lessons learned programs can be classified further as formal or informal. Formal LLP employ a standard, documented work process for lessons learned. They also are consistent across an organization and are well resourced. Informal programs, on the other hand, are more inconsistent and ad hoc. These programs may even be a grassroots effort with no official action taking place (CII 2007c).

Lessons Learned Process

The lessons learned process includes three key steps: collection, analysis, and implementation. Fig. 1 provides an overview of the lessons learned process. A detailed process map can be found in CII (2007b). Collection is the gathering of knowledge and experiences from individuals in the organization. Individuals may submit lessons by electronic means or by communicating ideas in formalized workshops. Collection can occur at various stages of project execution by different members of the organization, including project managers and project teams. After lessons are collected, they must be analyzed and validated before they are disseminated through the organization. Analysis can be conducted in a team setting or by an individual. This crucial portion of the lessons learned process guarantees that the information shared throughout the organization is correct and easily interpreted. Last, the lesson is implemented. This step is extremely important as lessons can only help an organization if they are put into action (Collision and Parcell 2005). Implementation can take many forms, ranging from publication of lessons in an electronic database to the changing of practices and procedures to reflect lessons learned.

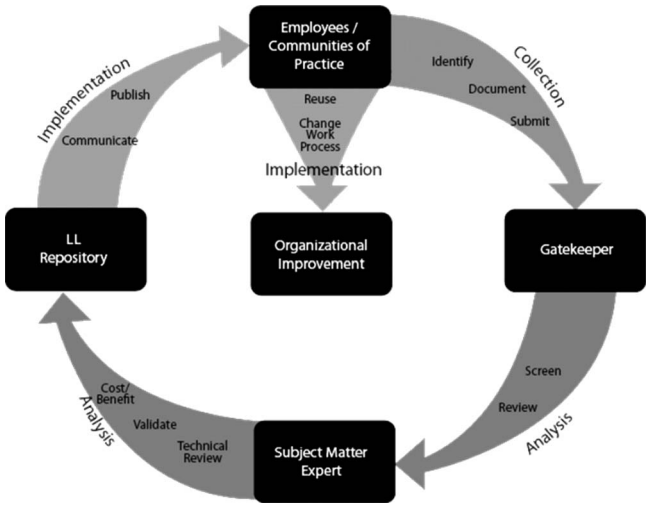


Fig. 1. Overview of the lessons learned process

Lessons Learned Programs and Knowledge Management Systems

Today's economy is driven by information and the value of an organization has become increasingly dependent on knowledge assets rather than tangible ones (Anumba et al. 2005). The global character of the economy also forces organizations to transmit information over both physical and cultural barriers every day; organizations now focus their efforts on managing knowledge as a "strategic resource" that must be transferred around the world 24 h a day, 7 days a week (Carnes and Breslau 2002). Knowledge management systems play a crucial role in organizations and are generators of innovation and competitive advantage. Knowledge management systems consist of many components such as work processes, training, mentoring programs, and so on. A LLP is a crucial component of knowledge management systems in organizations. In order for an individual to benefit from knowledge management and gain information and insight from an experience, he or she must consider the activity that occurred and extract a lesson learned (Collision and Parcell 2005).

Review of Existing Lessons Learned Programs

Although many construction organizations understand the usefulness of lessons learned, the concept is not pervasive throughout the industry; only a few organizations have been able to systematically identify and transfer meaningful knowledge from current projects to future projects (Disterer 2002; Carrillo 2005). The World Bank has even used lessons learned to avoid unnecessary mistakes and achieve better results in projects funded for developing countries (World Bank 2006).

The U.S. Army Construction Engineering Research Laboratory (CERL) was one of the first construction organizations to develop and implement a LLP and system. The Design Review

J. Constr. Eng. Manage., 2009, 135(6): 531-539

Checking System (DrChecks) is a system developed to allow multiple parties to review construction design documents and share comments over the internet using a client-server architecture (Nguyen et al. 1998). In doing so, lessons were extracted from the comments input into the system, resulting in an enhanced corporate knowledge repository. The program is also seamlessly integrated with another CERL-developed software tool, Corporate Lessons Learned (Soibelman et al. 2003; Gerber 2004). CERL system has evolved since and an enhanced version is currently available.

Organizations outside of the construction arena have successfully implemented LLP. Information about many of these programs is documented on many sources. For example, The U.S. Department of Energy (DOE) has an award-winning documented LLP (Carnes and Breslau 2002). The program was developed by a process improvement team in 1994, and documentation describing the system is widely accessible to employees and the general public. In addition, the DOE LLP also employs a database website for lesson submission and implementation (U.S. DOE 2006).

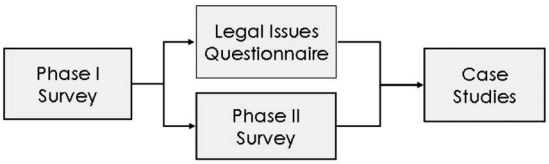
Military organizations are required to both record and refer to lessons learned. The United States Air Force, Army, Navy, Marines Corps, Army Corps of Engineers, and Coast Guard all employ lessons learned to help support operations (United States Department of Defense 2006). All of these organizations view lessons learned as a necessity for the safety of their troops and the success of their missions. The Canadian Army employs lessons learned to "support Army learning processes" (Canadian Army Lessons Learned Centre 2006) and the United Nations collects lessons to determine peacekeeping best practices (United Nations Department of Peacekeeping Operations 2006).

Environmental agencies such as the Environmental Protection Agency and the European Union have also implemented lesson learned database systems to gather information in order to "prevent major accidents and mitigate their consequences" (Balasubramanian and Louvar 2002).

Further, the Federal Highway Administration has begun to focus on continuous quality improvement, using lessons learned as one mechanism for this program. For example, Boston's Central Artery/Tunnel ("Big Dig") Project's collection of lessons has already proven useful to other projects of the same nature (Allen and Barnes 2004). Mega highway projects have benefited significantly from using the internet to share information and discuss lessons learned at conferences, meetings, and site visits.

The National Aeronautics and Space Administration (NASA) uses various means to communicate lessons from past programs and projects. NASA uses an engineering network that "promotes learning and sharing among NASA engineers" (NASA 2006). The agency also supports a Lessons Learned Information System, a web-based database that can be accessed by all employees to share knowledge and understanding gained through experience. In addition, according to the U.S. Government Accountability Office (GAO), lessons learned are also communicated through training, program reviews, and revisions to agency policies (GAO 2002). The European Space Agency has also conducted summits to determine effective methodologies for implementing lessons learned in their space programs (European Space Agency 2006).

Even professional organizations such as the Association of Soil and Foundation Engineers, the National Fire Protection Association, and the National Bureau of Standards have attempted to collect and disseminate performance and failure information to members in their specific disciplines (Kartam 1996). All of these organizations use lessons learned to share knowledge between members in order to improve industry practices.



— **Phase I Survey:** gather preliminary information on lessons learned practices, barriers, and tools.
— **Legal Issues Questionnaire:** understand the legal issues affecting lessons learned programs.
— **Phase II Survey:** collect in-depth data about lessons learned practices and procedures and assess the maturity of lessons learned programs in the construction industry.
— **Case Study Interviews:** provide further analysis of lessons learned best management practices and technologies.

Fig. 2. Overview of the data collection effort

Analysis of Lessons Learned Programs in the Construction Industry

As mentioned earlier, the goal of this research was to identify effective management practices and technologies for the development of a successful LLP in the construction industry. Therefore, effective lessons learned practices and information management resources were identified and investigated. The research methodology described in this section was employed to achieve the research objectives.

This research was initiated and funded by CII. In the 1990s, CII conducted a study to model the lessons learned process (CII 1998). Since then, advancements in management practices and technologies as well as the evolution of the business environment created new alternatives for collection, analysis and implement lessons learned. In order to put into operation a comprehensive LLP today there must be a focus on tools, people, and work processes. In 2005, CII Research Team 230 (RT230) was formed to identify the current best approaches used to collect, analyze, and implement lessons learned. The writers of this manuscript were key researchers on CII RT230.

In the beginning of the project, a detailed literature and background review was conducted in order to identify new developments in LLP. Extensive library and internet searches were performed to find data relating to lessons learned. Information from these sources were analyzed and incorporated into the research as applicable.

After receiving input from the research team and taking advantage of the knowledge acquired during the background review, the data collection effort started. Fig. 2 describes the main data collection activities conducted, as well as their main missions.

Phase I Survey was drafted and distributed to all CII member organizations. The 68 CII members that participated in this survey are listed in CII (2007a). This short survey had a 70% response rate and was used to collect preliminary information on lessons learned practices, barriers, and tools utilized by member organizations. The results of the Phase I Survey allowed the researchers to begin to identify effective practices, implementation barriers, current information technology tools, and other special considerations for lessons learned.

Once the results from the Phase I Survey were analyzed, it became evident that legal issues have a significant impact on lessons learned. Because of this, the researchers conducted a legal issues questionnaire, which was distributed only to the organizations represented in the research team. This questionnaire gave the team a better understanding of the legal issues threatening

J. Constr. Eng. Manage., 2009, 135(6): 531-539

Table 1. Lessons Learned Programs—Phase I Survey

LLP type	All (n=68)	Owner (n=37)	Contractor (n=31)
Informal	32 (47%)	17 (46%)	16 (52%)
Formal	32 (47%)	16 (43%)	15 (48%)
Does not exist	4 (6%)	4 (11%)	0 (0%)

lessons learned. The legal questionnaire was developed by the researchers with input from the research team.

Results from the Phase I Survey and the legal issues questionnaire prompted the research team to investigate methods to determine the maturity levels of LLP in the industry. In order to do this, the researchers distributed a Phase II Survey to all CII organizations with an active LLP. The Phase II Survey was developed by the researchers with extensive input from the research team. This survey provided in-depth data about organizational lessons learned practices and procedures. The Phase II Survey results also helped the research team to identify organizations to contact for the subsequent case study interviews.

The case study interviews were conducted for further analysis of lessons learned best management practices. A structured interview guide was used for the assessment. The guide was developed by the researchers with input from the research team. The sample for case studies was primarily chosen based on an assessment of already surveyed participants' LLP, and an attempt was also made to collect data from owners and contractors as well as organizations outside of CII.

Almost all organizations that participated in this research are members of the Construction Industry Institute. Statistically, the generalizations and findings from this study apply mostly to CII member organizations, which comprise several key players in the construction industry.

At the end of this research effort, the team was able to reach conclusions and provide recommendations for the construction industry regarding LLP. The multiple data collection approach used in this study provided rich insight into LLP within the industry. Each of these research steps is discussed in more detail in following sections.

Phase I Survey

The initial goal of this research effort was to get an overall "snapshot" of the current state of LLP in the construction industry. The Phase I Survey form was drafted to gather this information. This survey focused on the general characteristics of a LLP including the "how, what, when, where, and why" of the three main phases of the lessons learned process: collection, analysis, and implementation. The survey also focused on the people, processes, and technologies associated with lessons learned. Members of the research team reviewed the survey and provided feedback to the researchers before it was circulated. After gathering input from the research team and finalizing its structure, the survey was distributed to all CII-member organizations in November 2005. Data collection for this phase of the project was closed in January 2006. A total of 68 out of 96 organizations responded to the Phase I Survey. Owner organizations completed 37 surveys, and contractors completed the other 31 surveys.

The Phase I Survey gave an indication of the number of organizations that have implemented LLP. Table 1 illustrates the responses from Question 1.

One of the key findings of RT240 is that only 6% of the organizations who responded to the Phase I Survey do not have a LLP. This indicates an increase in the use of LLP since RT123's assessment in 1998. At that time sixteen percent of the surveyed organizations did not have a LLP. This indicates an evolution in the knowledge management area since that time. Because CII Research Report 123-11 (CII 1998) did not provide a list of the organizations that participated in the RT123 survey, it was impossible for this research effort to directly compare the subsamples. It was also found that more organizations use formal programs today than did 10 years ago. It is also interesting to note that every respondent who indicated they do not have a LLP is from an owner organization; all contractors reported have some type of LLP.

Table 2. Lessons Learned—Collection

How	All (n=62)	Formal (n=32)	Informal (n=30)	Owner (n=32)	Contractor (n=30)
Meetings/ interviews	45 (73%)	20 (63%)	25 (83%)	25 (78%)	20 (67%)
Electronically	38 (61%)	29 (91%)	9 (30%)	22 (69%)	16 (53%)
Paper forms	22 (35%)	12 (38%)	10 (33%)	13 (41%)	9 (3%)
Word of mouth	13 (21%)	4 (13%)	9 (30%)	7 (22%)	6 (20%)
Outside consultant	5 (8%)	4 (13%)	1 (3%)	4 (13%)	1 (3%)
Other	2 (3%)	0 (0%)	2 (7%)	1 (3%)	1 (3%)

The survey also identified several aspects of the state-of-the-art in LLP in each of the main steps of the lessons learned process. The findings include the following:

Collection

As illustrated in Table 2, lessons are typically collected in meetings or interviews. Technology tools are also commonly used to collect lessons. Most organizations that consider their programs to be formalized use an electronic method to collect lessons, unlike informal programs that typically use meetings and interviews.

Seventy-six percent of all respondents indicated that they collect lessons learned relating to construction, engineering, or design. Most organizations also collect safety and project controls lessons learned. There is not a large difference between the responses from owners and contractors; almost every organization collects the same type of information.

Many organizations make project managers responsible for collection. Multiple organizations designated the "quality group" as a responsible party for lessons learned collection. Most of the organizations that use a lessons learned process coordinator to collect lessons also have a formalized process. No organization places collection responsibility on the IT department or on an outside consultant.

Organizations typically collect lessons at the end of a project. Additionally, over half of the respondents collect lessons as they occur. The results for owners and contractors do not differ from one another on this item; however, most organizations with a formal LLP collect lessons at the time of the occurrence and most informal programs collect lessons at the end of the project.

Analysis

The results presented in Table 3 indicate that most lesson analysis takes place in a team setting at meetings. Many organizations also rely on subject matter experts to analyze lessons. Some of the other methods used to analyze lessons include using a lessons learned review team and the quality department to review lessons.

J. Constr. Eng. Manage., 2009, 135(6): 531-539

Table 3. Lessons Learned—Analysis

How	All (n=62)	Formal (n=32)	Informal (n=30)	Owner (n=32)	Contractor (n=30)
At meetings	38 (61%)	20 (63%)	18 (60%)	22 (69%)	16 (53%)
By a subject matter expert	26 (41%)	20 (63%)	6 (20%)	14 (44%)	12 (40%)
Informally	25 (40%)	4 (13%)	21 (70%)	15 (47%)	10 (33%)
Other	11 (18%)	7 (22%)	4 (13%)	5 (16%)	6 (20%)
Electronically	6 (10%)	6 (19%)	0 (0%)	2 (7%)	4 (13%)
By an outside consultant	1 (2%)	1 (3%)	0 (0%)	1 (3%)	0 (0%)

Other organizations indicated that they do not have an analysis procedure in place. Owners and contractors typically carry out analysis in the same fashion, but a difference can be seen between formal and informal programs. Many formal programs use subject matter experts to analyze lessons, whereas informal programs typically conduct analysis in a meeting session. It was also interesting to note that only 10% of all analyses is conducted electronically. This indicates that most organizations do not use any type of automated tool to analyze lessons.

During analysis, most organizations determine a lesson's applicability to new projects and the subjective analysis cost of its implementation compared to the benefit the organization would experience.

The responses indicated a variety of approaches to the timing of analysis during the process. The answers from owner and contractor organizations are very similar for this question. However, formal organizations differ from informal organizations; formal programs typically analyze lessons continuously or as they are collected, whereas informal programs tend to conduct analysis at the end of projects. Some of the "other" responses to this question suggest that analysis is not conducted in some organizations. Some respondents indicated that analysis is done before projects begin.

Implementation

Many organizations implement lessons in meetings or by changing their work processes. More owners try to incorporate lessons into work practices, and more contractors use lessons at project kick-offs. There is a striking difference between how formal and informal programs implement lessons. Sixty-six percent of all formal programs use an electronic database to help implement lessons; however, only 17% of informal programs use this type of resource. In addition, only 22% of formal programs use informal methods for lesson implementation, whereas 47% of informal programs rely on these informal means to execute lessons (see Table 4).

Both contractors and owners rely on members of future projects and their entire respective organization to implement lessons learned. These results were also typical for organizations that have either formal or informal LLP.

More than half of the surveys indicated that lessons are typically implemented during project planning. This response was consistent in both owner and contractor organizations as well as in formal and informal LLP.

Other Findings

The Phase I Survey also showed that there is no general agreement on who actually manages LLP. Most organizations that responded to the survey use a lessons learned archive and software to facilitate their program.

Approximately 16% of the surveyed organizations have faced or identified legal issues related to LLP, and 26% of the surveyed organizations use process metrics to assess program performance. Most LLP are less than 5 years old, and there was little information available on the approximate annual cost of maintaining the program. Table 5 shows that most of the survey respondents classified their programs as at least "somewhat effective" in adding value to the organization.

Results from the Phase I Survey and input from the industry steering team allowed the researchers, using the answers to all 21 questions, to identify the following seven key areas that affect the success of LLP (CII 2007c):

1. *Leadership:* The essence of leadership is to create an environment for success within an organization. Leaders provide vision and guidance through their words and their actions for the LLP. Consistent and aligned leadership action and communication throughout an organization is a key element in creating the environment for success.
2. *Lessons collection:* The collection of data is a fundamental step in any knowledge management process. Systems for collection can range from simple to complex, but must suit the needs of the data collection process. The system design is critical to the success or failure of the entire work flow process.
3. *Lesson analysis:* The process of analysis turns data into usable information. Analysis provides data consistency, and a method of prioritizing data to provide the most value to the organization. Experience of a subject matter expert is a valuable factor in lesson analysis.
4. *Lesson implementation:* Without implementation, the best information collection system and the best data analysis process will merely result in the best-kept secrets. The key to implementation is to include lessons learned as a required step in an organization's mainstream business processes. Seamless communication between the lessons

Table 4. Lessons Learned—Implementation

How	All (n=62)	Formal (n=32)	Informal (n=30)	Owner (n=32)	Contractor (n=30)
At meetings	28 (45%)	12 (38%)	16 (53%)	14 (44%)	14 (47%)
As part of changes to a work process	28 (45%)	16 (50%)	12 (40%)	16 (50%)	12 (40%)
At project kickoffs	27 (44%)	14 (44%)	13 (43%)	11 (34%)	16 (53%)
Through electronic databases	26 (42%)	21 (66%)	5 (17%)	14 (44%)	12 (40%)
Through training	22 (35%)	11 (34%)	11 (37%)	12 (38%)	10 (33%)
Informally	21 (34%)	7 (22%)	14 (47%)	14 (44%)	7 (23%)

J. Constr. Eng. Manage., 2009, 135(6): 531-539

Table 5. Effectiveness of Lessons Learned Programs

Effectiveness	All (%)	Owner (%)	Contractor (%)
Very effective	8	3	13
Somewhat effective	62	71	53
Neutral	20	13	27
Not effective	10	13	7
Detrimental	0	0	0

learned database and business processes will greatly facilitate implementation.

5. *Resources:* Allocation of required resources (human, monetary, material, technology) puts leadership commitment to the test. This is where "the rubber meets the road." Leadership commitment to the LLP is reflected in the allocation of resources and the training provided to employees.
6. *Maintenance and improvement:* Maintenance and improvement of a system or process is often the most overlooked aspect in planning for budget and resources. Every value stream should be periodically analyzed to eliminate waste, improve efficiency, and add value.
7. *Culture:* Development of culture within an organization is a long-term process. Leadership cannot dictate culture. Culture develops when actions and behaviors result in positive outcomes. Culture requires consistency in vision and mission throughout the organization. The organization must develop a "learning and teaching" culture to embrace and effectively use a LLP.

These seven characteristics became the main focus of the remaining research efforts, including the development of the research deliverables, and each key characteristic was explored further in the other surveys and case studies.

Legal Issues Questionnaire

Approximately 25% of Phase I Survey respondents who operate a formal LLP indicated that their organization has identified or faced legal issues related to LLP. To more clearly understand how legal experts perceive lessons learned, a legal issues questionnaire was conducted. Nine out of 16 organizations represented on the research team RT240 provided answers. Four of them were owners, and the other five were contractors (CII 2007c).

Lessons learned programs can present a variety of legal issues to an organization. Although according to the respondents, there is no precedent for litigation concerning a construction-specific LLP, most legal experts agree that the possible use of lessons learned documentation during discovery have potential legal consequence such as failure to follow standard processes or not taking corrective actions due to past mistakes.

To mitigate legal risks, organizations must clearly understand the legal issues associated with LLP. Respondents to the legal issues questionnaire described multiple ways to avoid legal repercussions which must be tailored to the needs of each specific organization. This may take the form of crafting a LLP that includes specific steps to address these concerns. One approach is to collect a lesson learned using generic descriptions or hypothetical scenarios, thus removing it from the actual circumstance that led to its discovery. Another practice is the submission of lessons learned to the legal department for review and approval. This approach would remove any legal conclusions or admissions against interest. Ultimately, each organization must establish its own comfort level and should seek expert legal advice to chart a course for its own LLP.

Most respondents agreed that if risks are correctly mitigated, LLP can significantly benefit an organization.

Phase II Survey

The Phase II Survey was drafted to gather more detailed data about lessons learned practices and procedures. This survey focused on the seven key characteristics of LLP that were identified from the Phase I Survey results. The survey was also used to gather information about the content that organizations capture. After the Phase II Survey was approved by the research team, it was sent to all respondents from the Phase I Survey who had indicated that their organization had a formal or informal program.

Thirty-six organizations out of 68 responded to the Phase II Survey. Twenty-one respondents were owners, and the remaining 15 were contractors. Twenty-one respondents deemed their LLP formal, and 15 deemed their programs informal.

Results showed that many different reasons motivated organizations to initiate a LLP. Most organizations reported developing a LLP to learn from past experiences and to stop making the same mistakes. Many organizations use the program to improve work processes and project performance. Lessons learned programs were also initiated to facilitate communication between projects and employees in the hope of better distributing knowledge and helping the organization continuously improve. Some programs are a result of a client request and others are a stepping stone to achieving the status of a learning organization.

In addition, many of the surveyed organizations reported multiple benefits from these programs. Organizations have found that lessons learned help facilitate knowledge dissemination. Lessons learned programs have also proved valuable to new projects by providing cost savings, increased application of best practices, and improved execution. Some organizations have enjoyed reduced rework, more satisfied employees, and increased profits as a result of their LLP. However, it is very difficult for an organization to quantify any improvements realized because most of these benefits are the result of multiple variables and cannot be attributed to LLP alone. Some organizations are still struggling with implementation of their LLP and have not seen any benefits.

Phase II survey results showed that 67% of the organizations have some type of documented LLP that employees must follow to ensure the program continues to be successful and consistent.

Leadership was identified as a key element to successful implementation of a LLP. Typically it was found that organizations' leaders support the LLP, but they do not have a cohesive vision for it.

Most lessons learned submission and collection processes within organizations are well defined; however, analysis and implementation procedures seem to be less robust and effective.

Most organizations that already have a LLP use a searchable, web based database (on the internet or an intranet) with some degree of security. Web based programs that permit lesson collection without regard to locale provide the greatest flexibility, but require a considerable commitment to establish, operate, and maintain the database. The information that IT tools make available provides an ideal platform for managing LLP. Automated analyses, artificial intelligence, and other hands-off features are beginning to find their way into LLP, but have not been widely

J. Constr. Eng. Manage., 2009, 135(6): 531-539

adopted. Similarly, subscription service and shopping cart tools are beginning to be used to distribute and retrieve lessons learned for use on upcoming projects.

Additionally, many respondents (49%) did not believe that their organization's employees are given the time and resources they need to effectively participate in their LLP. The survey indicated that although most employees participate in the program because they understand its value, most individuals have not made lessons learned an ingrained part of their daily activities—including using the knowledge as a resource when planning new work activities. Although several organizations have processes metrics associated with their LLP, the survey results showed that most organizations do not use any type of performance metric to evaluate their LLP. Process metrics simply document whether an action was taken and when and are easily quantifiable measures. Accurate, meaningful performance metrics, however, are difficult to ascertain. The performance and resulting economic benefits of lessons learned are difficult to identify for several reasons. First, when a lesson is learned and implemented, it is hard to project how far downstream the benefit will extend. Second, sometimes there is no economic baseline from which to measure the lesson. Although most activities can be evaluated and a cost can be developed for a work activity, there is a tendency to simply make the improvement without quantifying the benefit. People intrinsically know they are saving, and often that is enough reason to make the change. Therefore, when an organization tries to quantify the overall benefits across a LLP, there tend to be numerous gaps in economic analyses. Organizations are willing to establish and maintain LLP despite the lack of quantifiable economic data, which seems to indicate that most organizations inherently believe LLP are worth the effort.

Case Studies

After the Phase II Survey responses were thoroughly analyzed, organizations were selected for case study interviews. A total of ten case studies were performed involving 26 individuals. The objective of this final phase of the data collection process was to obtain detailed information from individuals involved in the LLP.

Eight out of the ten case study interviews were conducted with organizations who had submitted responses to the Phase II Survey. However, the researchers also talked to two other organizations that reportedly operate excellent LLP. Unlike the previous surveys, the case study interviews were designed to initiate a discussion between the researchers and the respondents using a structured interview guide.

Many common themes were identified and some surprising results were found. For example, no organization studied dedicates a full-time employee to their LLP. In most organizations, many individuals are working on the program on a part-time basis.

Even though there were many common themes, some differences between owners and contractors were apparent. The interviews showed that contractors are more likely to carry out the LLP if it is required by the client. Contractor organizations are more sensitive to legal issues. Owners do not spend much effort on justifying their LLP; they carry out the process because it will improve their business operations in the future. The writers believe that owners are able to derive the most value from lessons learned at the beginning of a project (during front end planning) when the project team consults past lessons and implements them on the project at hand. Conversely, contractors reap benefits from lessons learned during project execution because they are able to collect new lessons and learn from them how to better execute future projects.

Several unique features were identified when reviewing the case studies. Some organizations use a subscription service that notifies employees when lessons relevant to their work are submitted into the system. One organization uses a "shopping cart" service that allows users to select relevant lessons to print or share with other team members.

One nonconstruction organization studied, the U.S. Army, publishes several how-to handbooks, bulletins, initial impression reports, topical newsletters, and special studies as part of its LLP (U.S. Army 2006). In addition, this organization deploys mobile training teams to help implement lessons, and the organization generates operational records from historical data. Information is also disseminated through the request for information system, an online forum that allows individuals to ask questions and submit information. In total, the organization sends out thousands of publications per month in connection with its LLP.

Implementation Considerations

The data collection efforts reported in the previous section allowed the research team to identify the most effective management practices and technologies for lessons learned and provided the basis for various research deliverables (CII 2007b). For organizations that have already developed a LLP, a self-assessment questionnaire and a maturity model matrix were developed to determine its effectiveness with respect to the seven key program characteristics. For organizations without a current program, a jump start guide was compiled with recommended steps for the development of a program. In addition, a sample transactional work flow diagram was created to serve as a roadmap for typical lessons learned transactions. IT characteristics and other special considerations were also identified and analyzed. Together, these deliverables form a framework for organizations to integrate a LLP into their current work processes.

Conclusions

This research study found that the benefits of having a LLP are abundant. A LLP is an effective way to share information across all segments of an organization, including employees, projects, business lines, and cultures. In the last decade, the number of LLP has increased. Research indicated that ninety four percent of surveyed organizations operate a LLP. More experiences are being shared, and knowledge is expanding.

The need for an effective organization-wide LLP is now more critical than ever, for two main reasons: (1) the globalization of project execution; and (2) a considerable number of employees are approaching retirement. Globalization brings an array of challenges that can be addressed by a LLP that includes culture, language, distance, and diversity. Additionally, organizations can avoid the potential loss of critical knowledge assets through the execution of a LLP.

Researchers found that even though more LLP are being initiated, the potential for savings and improvement has not been fully met. Generally, the researchers concluded that some organizations have delayed launching a formal LLP due to their concerns over negative legal ramifications. Organization-generated measurement of the program's effectiveness proved disappointing. Al-

J. Constr. Eng. Manage., 2009, 135(6): 531-539

though several of the organizations surveyed reported that they do use process metrics, all were found to be lacking performance measurements. Only one organization uses a value-based survey that asks its users to measure the program's performance. Two conclusions arose from this finding: (1) it is difficult to quantify the value of a lesson; and (2) the need to "prove" the worth of the program from a financial or cost-benefit analysis is not a driving force for program support, although organizations do understand the "soft" value of a LLP.

Another area of concern was the issue of automation. All of the surveyed organizations that currently operate formal LLP are using internally developed automation tools. As part of the research deliverables, the characteristics and main features of lessons learned tools were compiled.

Research has proven there are seven crucial characteristics of a successful program. Typically, most organizations are stronger in some categories and weaker in others. The key to an effective program is to address all seven areas.

As almost all organizations surveyed are members of the Construction Industry Institute, the generalizations and findings from this study apply mostly to CII member organizations, which comprise several key players in the construction industry.

Recommendations

Based on the extensive data gathered, the research team recommends the following:

- Organizations should become "teaching" organizations, rather than organizations that only collect or learn from the past in an ad hoc manner. Becoming a teaching organization implies an active and broad-based implementation strategy rather than passively assuming that individuals will participate in the program.
- Organizations should adopt an active implementation strategy for ensuring that lessons are used. This will entail required lessons learned reviews during project development meetings and changing internal work processes to reflect past lessons. It also will require "pushing" lessons out to the field by addressing requests for information, or developing situation-specific booklets and training based on acquired lessons. Mentoring by experienced personnel is an important characteristic of a teaching organization.
- Leadership is very important to the success of a LLP. Lessons even though learned programs can attain some success when created from the bottom-up, the overarching success of the program cannot be achieved without top-level leadership support.
- The importance of culture should not be underestimated. Whether it is intraorganization cultural differences such as those between engineering, construction or operations, or differences caused by different geographical locations or languages, culture should be addressed in development and maintenance of a LLP to ensure consistent use.
- The quality of lessons learned is more important than the quantity of lessons in the database. An active maintenance and improvement effort will help make the lessons more valid and implementable.
- Both owners and contractors can benefit from LLP. Necessarily, the captured lessons learned will be focused in different areas based on the business needs of the organization. Owners will probably focus more on lessons concerning front end planning, overarching project control and operational issues. Contractors will be more concerned about project design, construction, and turnover issues. Each party can gain insight and knowledge from the other's lessons.

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