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An Investigative Study of the Application of Lessons Learned Systems in Construction Projects

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Abstract

Construction projects in Hong Kong involve huge investments of capital, resources and time. Good management practices can maximize profits in construction projects. However, almost no organizations have adopted formal systems to manage such practices. Lessons learned systems (LLS) supported by knowledge management and organizational learning principles have achieved many success stories in other countries. The LLS includes the process of acquiring, handling and verifying good or bad practices from projects in different stages, disseminating the verified and approved lessons to related parties, and recording such practices in appropriate ways for future reuse. Construction professionals are not concerned with how data is recorded. In fact, project professionals mainly transfer management practices among those team members involved in a project, but do not do so to the larger organization. Needless to say, organizational learning does not exist in these construction organizations. More often than not, mistakes are repeated and successes are not continued in future projects. "Reinventing the wheel" is a frequent phenomenon and projects are not executed as well as they should be. The quantitative analysis of a questionnaire survey shows that LLS can improve professionals' performance in construction projects. The survey also investigated professionals' preferred methods of acquiring, handling, verifying and disseminating the lessons learned. The findings further suggest that real-life adoption of LLS can lead to the successful management of construction projects.

Keywords: Construction Projects, Knowledge Management, Lessons Learned System, Organizational Learning

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Introduction

Although the idea of learning from experience is always a hot issue, formalized systems for capturing and disseminating lessons within organizations and across projects have received increased attention in recent years. Interest in such lessons-learned systems (LLSs) has grown through popular concepts such as the “learning organization” (Senge, 1990), through developments in knowledge management (Davenport and Prusak, 1998), and through technological advancements that hold the promise of wider, more efficient distribution of lessons within an organization. This growth is especially evident in the commercial sector, where a firm’s learning capabilities and knowledge are viewed as strategic resources that give it competitive advantage (Davenport, 1997; Zack, 1999a). In addition, LLSs have been used widely in government and military organizations, as crisis, conflicts and wars are costly events which can cause casualties and fatalities, not to mention wasting resources. Amid this growing interest, a variety of forms of LLS have emerged, from passive (U.S. Army, 1997) and active collection (Knight and Aha, 2000) to “interactive” (Weber *et al*., 2000) or “intelligent” systems (Aha, 2000). Reimer (1998) found that standalone lessons learned systems do not reflect the central KM effort within organizations and must be entrenched in the processes they are intended to support. As Zack (1999b) noted, very little research has been done regarding the most appropriate LLS form for a particular organization. With an inadequate understanding of design issues and alternatives, management may implement systems that do not fit their organizations, are underutilized or do not promote knowledge sharing and reuse. Nowadays, there is a common understanding that lessons in the LLS have to be validated for correctness and should have an impact on an organization’s processes (Secchi *et al.,* 1999).

The construction industry presents particular challenges for the design of LLSs, as it encompasses multiple contexts - those of business, technology, process and the separation of the design and construction stages, to name a few - and multiple stakeholders with often competing interests. Its processes are idiosyncratic (i.e. different parties improvise different solutions to unique challenges) and contextual (i.e. different types of projects pose different kinds of challenges). America’s Construction Industry Institute conducted a large-scale investigation of LL processes, carried out by its Modeling Lessons Learned Research Team (Fisher *et al*., 1998). Out of the 2400 organizations surveyed, they found strong evidence that most organizations were using insufficient dissemination processes.

This research is significant to construction practitioners in that the proper sharing, capture and reuse of lessons learned minimizes the risk of reinventing the wheel and repeating costly mistakes, as well as offering many other benefits.

Lessons Learned System

The term “lessons learned system” in this paper refers to the activities, people, and products that support the collection, verification, storage, sharing, dissemination and reuse of verified lessons in organizations. Definitions of *lessons learned* vary. Although the U.S. Army defines

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them as “validated knowledge and experience derived from observations and historical study of military training, exercises, and combat operations” (U.S. Army, 1997, p. 1), in the Marine Corps they are “procedures developed to ‘work around’ shortfalls in doctrine, organization, equipment, training and education, and facilities and support” (U.S. Marine Corps, 1994, p. 1). Secchi *et al.,* (1999, p. 57) provided a comprehensive definition that has been widely used by various space agencies:

> A lesson learned is 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 … 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.

Most systems in current use are web-based. By adopting LLS in construction, professionals can learn from lessons from past projects and share their knowledge or experience to create new lessons learned. As a result, it will facilitate the transfer from individual knowledge to become organizational knowledge.

The cultivation of learning within project-based organizations is becoming increasingly important as projects do not support any natural transfer mechanism, nor is there any project memory or infrastructure. Organizational learning (Argyris, 1999) is usually defined in terms of members learning from each other, that is, when members share “theories of action” (Argyris and Schön, 1978) or “mental models” (Senge, 1990). Further, Malhotra (1996) interprets organizational learning as the ability of an organization to gain insight and understanding from experience through experimentation, observation, analysis, and a willingness to examine both successes and failures. Lipshitz *et al.* (1996) took a structural approach by focusing on organizational mechanisms that facilitate, make explicit, or establish routines for such sharing. These mechanisms are the “institutionalized structural and procedural arrangements that allow organizations to systematically collect, analyze, store, disseminate, and use information that is relevant to the effectiveness of the organization” (Lipshitz *et al.,* 1996, p. 293). Such mechanisms include organization histories, project reports, after-action reviews (Busby, 1999) and, more generally, LLSs. These mechanisms are intended to allow an individual’s learning to become recorded in an organization’s documents, processes, and other “memory” media in such a way that other members may learn from it, thereby contributing to improved effectiveness or facilitating an organization’s adaptation to a changing environment (Argote and McGrath 1993).

Based upon prior research studies and knowledge gaps identified, this paper focuses on two questions:

- What are the current practices in the construction industry in managing lessons learned?
- What design aspects and issues are critical to the design and adoption of LLSs?

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Research Methodology

As the aim of this study was to investigate the feasibility of applying LLS in construction projects, target respondents were professionals such as architects, surveyors, engineers working in project management departments of property developers, or government bodies. The reason for not choosing one specific type of professional for the study was that organizational learning and lessons learned are the responsibility of the whole organization and not just one particular discipline.

A questionnaire was used in this research as, firstly, questionnaires can cover a wide range of professionals in the industry. Secondly, it was estimated that the questionnaire required 15 - 20 minutes to complete, so, compared with interviews, it was not too demanding on the professionals' time. An invitation letter was issued by email to potential respondents to explain the purpose of the research as well as to find out their preferred methods of receiving the questionnaire. They could choose to receive the questionnaire by mail, e-mail or fax, by selecting the appropriate icon. The advantage of this method was that a predictable response rate could be obtained through the number of replies. In addition, professionals could choose their preferred method of receiving and then filling out the questionnaire, so that the response rate could be enhanced.

Survey Findings and Analysis

The sample population included small, medium and large organizations. 113 sets of questionnaires were sent out and 34 responses were received. The response rate was about 29%. One participant filled in some wrong information, so that 33 valid questionnaires were used in data analysis.

Out of the total number of respondents, 9 (27%) had less than 3 years' work experience, 8 (24%) had 3-6 years of experience, 6 (15%) had 7-10 years and 11 (34%) had more than 10 years of work experience. Respondents included both junior and experienced professionals, so that opinions from the questionnaire findings covered a balanced view from different age and experience groups. In addition, 26 respondents (about 79%) were working in organizations with more than 50 employees. They were mainly property development firms and government departments. The remaining 7 respondents (about 21%) came from small and medium-sized firms with 20-50 employees.

Table 1 Distribution of professional disciplines

	Architect	Surveyor	Engineer	Project Management	Others
Number	2	16	3	8	4
Percentage	6%	49%	9%	24%	12%

Table 1 shows that 16 respondents (49%) were surveyors because a large proportion of project management works involve surveying knowledge such as cost estimates, site

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surveys, valuations, etc. Only 2 respondents were architects. Four respondents were classified as others, as they were financial planners/controllers in construction projects.

Do you often record good practices during the running of projects?

(a) For individual use, (b) For team members' use, and (c) As a company asset

Table 2 Mean of recording good practices during the running of projects

	Often (4)	Sometimes (3)	Seldom (2)	Never (1)	Mean
a	10	18	4	1	3.12
b	3	10	20	0	2.48
c	2	10	12	9	2.15

Overall, respondents noted that they sometimes (mean = 3.12) recorded good practices for individual use during the running of projects (Table 2). However, they seldom recorded good practices for team mates (mean = 2.48) or for the company (mean = 2.15). Nine respondents (27%) had never recorded any good practices for the company. As a result, other professionals in the same organization could not re-use what they had learned. It is concluded that recording good practices in the project running stage is not common, and in the worst situation it has never existed. Good practices in projects may be easily lost after they are discovered.

Do you often record good practices upon completion of projects?

(a) For individual use, (b) For team members' use, and (c) As a company asset

Table 3 Mean of recording good practices upon completion of projects

	Often (4)	Sometimes (3)	Seldom (2)	Never (1)	Mean
a	15	11	6	1	3.21
b	3	16	11	3	2.58
c	6	16	9	2	2.79

The mean for this question was higher than for the previous one because individuals and companies usually record and store project documents upon completion of projects, but not during their execution. The means of the three situations range from 2.79 to 3.21, showing that these activities are not popular in construction projects (Table 3). Good practices may be lost both during the running of projects and after they are completed.

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Do you often record bad practices during the running of projects?

(a) For individual use, (b) For team members' use, and (c) As a company asset

Table 4 Mean of recording bad practices during the running of projects

	Often (4)	Sometimes (3)	Seldom (2)	Never (1)	Mean
a	3	6	23	2	2.36
b	2	7	18	6	2.15
c	6	12	12	3	2.64

The rate of recording bad practices is lower than that of recording good practices during the running of projects. The mean of all situations (2.15 - 2.64) in this question was near to "seldom" (Table 4). It is understandable that professionals avoid recording bad practices, as such failures may affect their career, or they may not be able to see any value in them.

Do you often record bad practices upon completion of projects?

(a) For individual use, (b) For team members' use, and (c) As a company asset

Table 5 Mean of recording bad practices upon completion of projects

	Often (4)	Sometimes (3)	Seldom (2)	Never (1)	Mean
a	3	9	18	3	2.36
b	2	4	21	6	2.06
c	6	10	14	3	2.58

The result of this question is similar to that of the previous question. Overall, respondents noted that they seldom (mean = 2.06 - 2.58) recorded bad practices upon completion of projects for individual, team or company use (Table 5).

Do you think the following methods are good sources of lessons learned?

(a) Formal discussions with team mates, (b) Informal discussions with team mates, (c) Intranet / company database, (d) Knowledge/experience sharing meeting, (e) Failed practices in projects, and (f) Good practices in projects

Table 6 Sources of lessons learned

	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)	Mean	Rank
a	3	11	16	6	0	3.33	5
b	3	13	7	10	0	3.27	6
c	6	16	10	1	0	3.82	3
d	4	10	13	6	0	3.36	4
e	12	9	11	1	0	3.97	1
f	10	12	10	1	0	3.94	2

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The results show that the six mean scores are close to each other and are rather high (3.27 - 3.94) (Table 6). This means that respondents suggested that all of the above methods can be good sources of lessons learned. In fact, according to GAO (2002), the collection of lessons may come from as many sources as an organization is willing to solicit. Respondents agree that failed practices in projects (mean = 3.97, rank 1) and good practices in projects (mean = 3.94, rank 2) are good sources of lessons learned. According to GAO (2002), lessons learned can be based upon positive experiences that prevent accidents or save money, or on negative experiences that result in undesirable outcomes. Findings in this question match the main function of lesson learned systems in that they try to record good and bad practices as lessons learned in projects and reuse such lessons learned in future projects to improve performance.

Do you think the following timing is appropriate for acquiring lessons learned?

(a) Milestone reviews, (b) After key decision-making, (c) After completion of a whole project, (d) After a good practice has been made, and (e) After a bad practice has been made

Table 7 Timing appropriate for acquiring lessons learned

	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)	Mean	Rank
a	5	15	10	3	0	3.67	5
b	8	18	6	1	0	4.00	1
c	2	22	8	0	1	3.73	4
d	9	11	13	0	0	3.88	3
e	9	13	10	1	0	3.91	2

The means of this question are close (mean = 3.67 - 4). Table 7 shows that respondents agreed that all of the above timing is appropriate for acquiring lessons learned. In fact, no matter when professionals discover meaningful lessons, they should record them immediately. It should be noted that “after key decision-making” is ranked first (mean = 4), as key decisions are often repeated in projects and it is valuable to record and reuse those lessons within the same project.

Do you think the following personnel are suitable to verify lessons learned?

(a) Knowledge manager, (b) Top management, (c) Lessons learned committee, and (d) Team members from that project

Table 8 Personnel suitable to verify lessons learned

	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)	Mean	Rank
a	5	18	10	0	0	3.85	1
b	5	11	14	3	0	3.55	2
c	5	12	12	4	0	3.55	2
d	3	5	20	5	0	3.18	4

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Overall, respondents agreed that the knowledge manager (mean = 3.85) is in the best position to verify lessons learned (Table 8). As recommended previously, an experienced knowledge manager is needed in the initial stage of LLS development. However, respondents also noted that top management (mean = 3.55) and a lessons learned committee (mean = 3.55) may also be suitable for verifying lessons learned if there is no specific position within an organization. Top management and a lessons learned committee have their own social networks as well as intelligence sources about current and good construction project practices, so that working lessons can be verified by them. It is suggested that a lessons learned committee which includes a knowledge manager and top management can achieve better results in validating lessons learned.

Do you think the following channels are suitable for disseminating lessons learned?

(a) Document distribution, (b) Intranet / database (internal access), (c) Company website (public access), (d) E-mail distribution, and (e) Lessons learned meetings

Table 9 Channels suitable for disseminating lessons learned

	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)	Mean	Rank
a	12	14	7	0	0	4.15	1
b	2	12	16	3	0	3.39	4
c	2	10	13	8	0	3.18	5
d	10	17	6	0	0	4.12	2
e	11	11	11	0	0	4.00	3

Overall, respondents agreed on document (mean = 4.15) and e-mail distribution (mean = 4.12) as suitable channels for disseminating lessons learned (Table 9). This is because written documents and e-mails are commonly used communication methods among professionals nowadays in transferring data information and knowledge. Intranets/databases (mean = 3.39) and company websites (mean = 3.18) do not seem to be recommended by professionals, as these methods are an indirect means for them to get information. In addition, not all organizations have their own websites or intranets.

What are the reasons that you do not recommend the adoption of lessons learned systems?

(a) Lack of success model, (b) Lack of resources, (c) Lack of time, (d) Lack of top management support, (e) Lack of participation, and (f) Project performance is good enough

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Table 10 Reasons for not recommending the adoption of lessons learned systems

	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)	Mean	Rank
a	3	10	15	3	2	3.27	3
b	10	13	6	3	1	3.85	1
c	8	10	13	0	2	3.67	2
d	4	10	10	4	5	3.12	4
e	2	8	12	9	2	2.97	6
f	2	6	20	3	2	3.09	5

Overall, respondents agreed that lack of resources (mean = 3.85) and time (mean = 3.67) are the main reasons they do not recommend the development of LLSs (Table 10). Today, many organizations are competing in a fierce environment and trying to cut resources or reduce costs in order to maintain their survivability. It is not surprising that many organizations nowadays do not have the forward-looking vision necessary to invest extra resources and time to employ a knowledge manager and develop LLSs. In addition, professionals are usually engaged in their daily work activities and may not see the benefits of starting, running and maintaining LLSs within their organizations.

Conclusions and Recommendations

Recording good or bad practices at different stages of projects is not common in the construction industry. Survey findings show that there are three important phenomena in recording lessons learned by construction professionals. Firstly, professionals sometimes record good/bad practices during the running of projects and upon their completion. However, in the worst scenarios, they never record any lessons learned during the running of projects, so that important experience gained is totally lost. Secondly, professionals sometimes record good practices but the frequency of recording bad practices or failures is much lower than that of recording good ones. To learn from failures is very important, as failures may cause unpredictable losses that affect the survival of an organization or result in lawsuits. Finally, most of the recorded good/bad practices are for individual consumption, but not for team or organizational use. Since experience resides in the minds of professionals, when they leave or retire from an organization, all-important experience will disappear.

Questionnaire findings show that professional knowledge and work experience are important for professionals to achieve success in projects. However, they do not reuse their knowledge or experience in the best ways to handle projects. Professionals note that they cannot always achieve successes and avoid failures. Organizational learning in construction project-based organizations seemingly does not exist, as there is no effective learning across projects. Lessons learned systems supported by knowledge management and organizational learning approaches can be used to develop validated experiential lessons. Professionals can review

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and reuse previous lessons learned to improve upon future decisions. As a result, they can improve on the performance of construction projects as well as reduce resources deployed.

As for the best time at which to acquire lessons learned, professionals think that there is no specific period for such activity, as any timeframe contains meaningful lessons to be learned. In order to have a better design of LLS, professionals agree that a knowledge manager should be employed to handle lessons learned, since professionals may not have the experience, time or resources to handle such matters, and a dedicated member of staff can help them to develop and maintain the system. They also suggested that verifying lessons learned can be best achieved by co-operation between the knowledge manager, top management and the lessons learned committee. Finally, the professionals surveyed in this study suggested that distribution by e-mail or written documents are suitable means for disseminating lessons learned, as these methods involve direct information and knowledge transfer; indirect methods such as intranets or websites are not recommended.

This research shows that professionals in construction projects are not much concerned with the transfer of lessons across projects. Learning occurs randomly and accidentally within organizations or projects. The following four recommendations can foster the development of LLS in construction projects. Firstly, full research and evaluation should be carried out before developing LLS in an organization. Existing LLSs such as the U.S. Army Lessons Learned System and others are worthwhile for organizations to review and make reference to. Secondly, well-planned training is important for top management and employees, to ensure that everyone within the organization knows the importance and application of LLS. Thirdly, a knowledge manager should be employed at the initial stage to help with the development and maintenance of the LLS. Finally, monitoring of organizational resources is needed, as the survey findings reveal that the lack of time and resources can be critical to the capture and reuse of working lessons in the lessons learned system.

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