Enhancing Quality of Lessons Learned: Evaluating Knowledge Management Practices in Project Management

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Abstract

Lessons learned (LL), or knowledge obtained from experiences, are keys to effective learning in project-oriented organizations, especially in the construction industry. Many public or private organizations have developed information technology systems for collecting, sharing and maintaining lessons learned as a crucial element of their knowledge management policies. For efficient knowledge sharing and dissemination, the contents of the learned lessons are usually codified into explicit and structured knowledge in textual form like cases, reports, research studies, best practices or guidelines that are accessible to their staff for reference. While issues about data and information quality have been widely investigated, there is little research on the quality of the content of knowledge per se. Evaluation of lessons learned systems in terms of knowledge quality has not been conducted, implying a lack of detailed criteria for effective codification of knowledge, which is one of the key factors for successful knowledge management. This paper offers a brief overview of LL followed by discussion on the quality dimensions of knowledge with a view to answering the question: “What kinds of lessons are more effective in terms of learning and transferring knowledge?” This is related to the way of evaluating LL, together with suggestions on how to apply these quality dimensions in the perspectives of context and content. For example, many lessons learned programs focus on the 'what' and 'how' aspects but do not adequately address the 'why' perspective. Knowing the reasons why past practices succeeded or failed is essential for project team members in order to avoid re-inventing the wheel and to achieve continuous improvement. Project team members can reach informed decisions not just by blindly following rules and decisions but also by reflecting on the reasons why their predecessors have made the choices and taken the actions specified in the lessons learned. A quality lesson learned should state the rationales behind the decisions in the content. This study contributes to project management research by showing the importance of good contextual knowledge and content in lessons learned on decision-making. The “Failure Knowledge Database”, a knowledge database of failure cases, is used as an example for illustration.

Keywords: knowledge management, lessons learned, failure, quality, failure knowledge database

1. Introduction

1.1 Lessons learned in knowledge distillation

As an important component in knowledge management, lessons learned (LL) are the knowledge gained from people's successful or failed experience. From the perspective of knowledge processing, an LL program can be considered as a set of concepts and techniques of collecting, validating, analyzing, storing, transferring and using knowledge from the lessons. LL is particularly important for project-based organizations, such as those in the construction industry. However, it is difficult for project teams to learn, transfer and retain knowledge, because of the diverse expertise and different backgrounds of team members, frequent personnel changes and temporary nature of projects (Lo & Fong 2009). Various kinds of knowledge bases, case retrieval systems and document repositories have been developed to capture, store and use LL. In the following section, this paper gives a brief overview of LL and discusses general quality dimensions of LL with a view to answering the question: "What kinds of lessons are more effective in terms of learning and transferring knowledge?" which is related to the way of evaluating LL.

Taking the constructivist approach, knowledge is not simply an object which exists "out there", but concepts constructed through people's intellectual efforts along the knowledge process. If we take the petroleum industry as a metaphor, then at the lowest level, the experiences gained by individuals and teams, just like crude oil drilled from the earth, are consolidated and transformed into LLs by knowledge-capturing activities such as after action review, event-recording by knowledge historians, etc. Later on, LLs are gradually refined and converted into best practices after discussions and debates within the community, experimentation with the actions recommended in the LL, etc. Knowledge is validated. Useless side products, say, irrelevant or contradictory knowledge, are removed – what we can describe as the "distillation of knowledge". Finally, some of the best practices survive and are condensed into widely recognized standards, usually after successful implementation of the practices for years, or acceptance by stakeholders in industries. Thus a hierarchy of products of knowledge distillation is formed as illustrated in Figure 1.

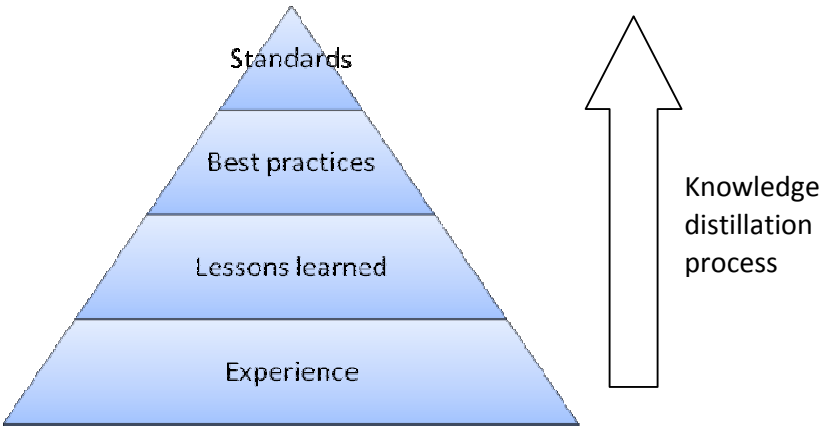

Figure 1: Products of knowledge distillation

1.2 Types and examples of lessons learned

With a broad definition and a wide variety, LLs can be classified according to different facets, such as formats, content domains, functions, and consequences of the lessons, to name just a few. The format of an LL falls along a long continuum with a well-structured table of information at one end and a loosely-presented story at the other. Since there is little restriction regarding its content, an LL can cover a broad range of domains, from engineering designs to private lives. The functional roles of an LL also vary: as an immediate product of project reviews, as materials for training purposes, etc. Finally, the consequence of an LL may be categorized on the basis of the degree of benefits or damage (no matter whether actual or would-be) that results from the lesson, namely the *success*, *near miss* or *failure*. For example, an official report about a site accident submitted by the safety officer on a pre-defined template stipulated by safety regulations can be described as a well-structured LL on construction, while a story told by a veteran member of a building project team on his personal experience of a successful negotiation with a contractor on budget cutting is a typical non-structured LL on project management. Speeches delivered by guests in an award presentation ceremony on the opening of a road tunnel may be full of LLs on success so as to praise the workers for the completion of such a huge and complex project. An academic study on a tragic bridge collapse commissioned by a government is definitely an LL from failures, while an investigation report on a narrowly avoided plane crash is a good example of LL on a near miss.

As LL are captured from experience, the content of the LL should ideally be real or authentic, in contrast to other forms of knowledge representations, like stories or fables, in which the content can be factitious, or only partly real. However, for the sake of privacy and other reasons, the details of LLs may sometimes be intentionally modified without detriment to the integrity of the knowledge. An LL is said to be *tacit* if the knowledge of its content cannot be articulated, or *explicit* when the knowledge has been codified. Official reports, the results of research studies, best practices or guidelines, if they consist of knowledge gained from experience, are good examples of explicit LLs.

Many public or private organizations have developed knowledge management systems for collecting, sharing and maintaining knowledge. For efficient sharing and dissemination, knowledge is usually codified into explicit and structured textual forms that are made accessible to their staff for reference. Many organizations want their staff to learn from the codified knowledge as a way of continuous improvement. These documents then serve as representative materials for reflecting organizations' approaches to learning. Nevertheless, authentic LLs of organizations are usually not open to outsiders, probably because of the lack of practices of keeping LL, confidentiality or fear of competition from rivals, except for a few public organizations or quasi-government agencies, such as the Japan Science and Technology Agency (Japan), NASA (USA), the Hospital Authority (Hong Kong).

1.3 A special type of lesson learned – lessons learned from failures

Lessons from failures are a special kind of LL. Literally, "failure" means "a lack of success in doing or achieving something, especially in relation to a particular activity" (Collins Cobuild English Dictionary for Advanced Learners 2001), or "omission of occurrence or performance, or a failing to perform a duty or expected action" (Merriam-Webster's Online Dictionary 2010). In the project

management environment, failure can be interpreted as the result unexpected at the beginning of a project (Hatamura 2009). It is understandable that individuals and organizations prefer success over failure due to the credits and rewards brought by success. Even discussions of success are more welcome, and people are better motivated by success than by failures. Discussing failures is avoided because of the blame usually accompanying such discussion, as well as the frustration caused and the damage inflicted on people's confidence (Sitkin 1992). Fear of losing face is another reason. Not surprisingly, people tend to embrace successful experience and avoid stories of failure. This bias leads to imbalance between these two sources of learning possibilities.

Failures are necessary in the sense that they are essentially prerequisites for learning, especially for learning lessons with repeated minor failures (Sitkin 1992; Hatamura 2009). First, small successes may unintentionally weaken attention. Secondly, failure, at a modest level, can encourage employees of an organization to take risks and foster resilience-enhancing experimentation. Yet this benefit of failure experience for individual and organizational learning in terms of encouraging exploratory actions has been overlooked (Sitkin 1992). Lastly, discussion of conflicting issues leads to double-loop learning, which stimulates deep level reflection. Learning occurs when errors are detected and corrected (Argyris et al. 1985). Organizations needs double-loop learning focused on the root causes of errors. Organizations require modification of an organization's underlying norms, policies and objectives, which is an essential element for corrective action such as an organizational self-appraisal exercise. In view of the serious consequence of failures, the study of LL from failures, as well as near misses, is obviously of concern to the construction industry.

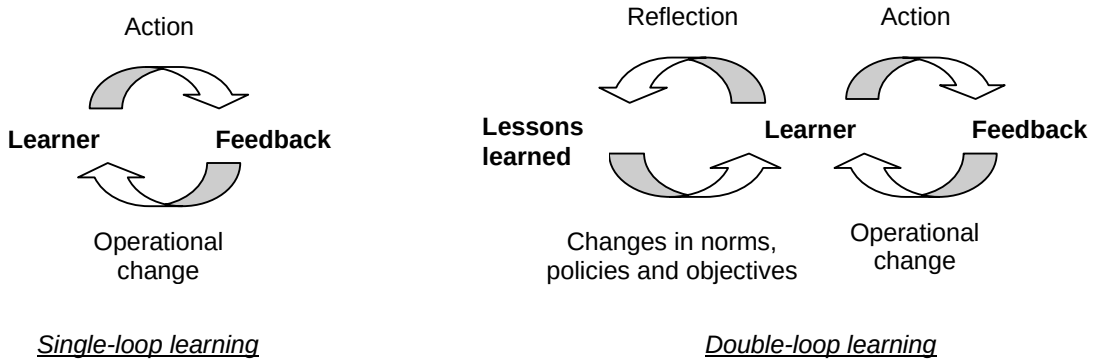

Figure 2: Single- and double-loop learning

2. Quality of lessons learned

Issues surrounding data and information quality have been widely studied. Surveys have been conducted to identify dimensions of data and information quality (Madnick 2009; Redman 2005; Pipino et al. 2005; Eppler 2006). Criteria raised on information quality include relevancy, accuracy, timeliness, cost, validity, empirical evidence, completeness, comprehensiveness, clarity, correctness, security, interpretability, conclusiveness, etc. By contrast, studies that focus on the quality of knowledge are rarely found in the literature. There is little research on the quality of the content of knowledge per se except for a few studies concerning management or IT aspects, e.g. about enablers

and constraints of KM in human enterprises (Malhotra 2003), security, control and assurance of knowledge management systems (KMS) (Jamieson & Handzic 2003) and KM software (Tsui 2003). Although surveys on the collection, format and implementation have been conducted by researchers (Caldas et al. 2009), similar inquiries regarding the content of knowledge are not enough. Evaluation on LL systems in terms of knowledge quality has not been widely conducted. There remains a lack of detailed criteria in the literature for deciding the most efficient and effective way of codification. Davenport & Prusak (1998) state that the thing delivered is more important than the delivery vehicle. Given the increasing amount of knowledge, the quality of knowledge has become one of the key factors for successful knowledge management.

Although there is neither general agreement on knowledge quality dimensions nor a commonly accepted definition of exactly what dimensions of knowledge quality mean, a diverse set of dimensions has been mentioned in the literature. Table 1 covers some of the examples of dimensions of knowledge quality found in the literature which are considered as relatively important. These quality dimensions are not exhaustive. There are still important dimensions not mentioned in the literature, e.g. learnability. On the other hand, the concepts brought by the dimensions can be overlapping. It can be difficult to draw a line between them, as in the case of importance and applicability. However, Table 1 serves as a good start for choosing criteria for evaluating the quality of knowledge of an LL. It will be of great significance to study the effectiveness of knowledge transfer of LLs with the quality given in Table 1.

Table 1: Examples of dimensions of knowledge quality

Dimensions	***Explanation***	***Literature***
Location	*Position of knowledge in organization, proximity to needs*	*Fong & Choi 2008*
Originality	*Degree of innovation relative to users*	*Cantner et al. 2009; Mol & Birkinshaw 2009*
Comprehen-sibility	*Clarity and ambiguity: number of possible meanings which may cause confusion*	*Holsapple 2003*
Validity	*Accuracy, completeness and consistency*	*Holsapple 2003*
Reliability	*How reliable the knowledge source is*	*Kwong & Lee 2009; Mort 2001*
Relevance	*Pertinence to a problem*	*Cortada 2009*
Importance	*Crucial for the task*	*Fong & Choi 2009*
Proficiency	*Level of expertise in the subject area*	*Wiig 1993*
Applicability	*Knowledge can be universally applicable or localized for special circumstances and contexts*	*Fong & Choi 2009*
Predictive power	*How far can the knowledge claim to predict future events accurately*	*Harvanach 2003*
Viscosity	*Richness or thickness of knowledge, quality of absorption*	*Szulanski 2003; Zhao & Anand 2009*

It is reasonable to assume that no single dimension can dominate the judging of knowledge quality. Multiple dimensions can enrich the understanding of knowledge content and knowledge processes. The crux is to discover the correct combination of dimensions. Some of the quality dimensions are content-related, for example, clarity, ambiguity, completeness, consistency, while some are context-related, such as location, applicability, etc. Generally speaking, the quality dimensions can be applied from two approaches: the context and content of LL.

3. Context of lessons learned

3.1 Meta-knowledge – what is the lesson about?

Meta-knowledge is knowledge about knowledge. In data management, the use of meta-data has been standardized to articulate a context for objects of interest based on International Organization for Standardization (ISO) official standards such as the Dublin Core Metadata Element Set, which consists of elements like title, creator, subject, publisher, language, etc. (Dublin Core Metadata Initiative 2010). They are primarily designed for enhancing the interoperability of meta-data. Similar relations can be applied to meta-knowledge and knowledge. An overall picture of the LL is necessary for users to place the lessons in appropriate positions. With reference to Table 1, the dimensions of location, importance and applicability all fall within the category of meta-knowledge, which provides a time-space-scope framework for the lessons. Such meta-knowledge can be found in many LL systems. Specifically, knowledge about creator and contributor are highly useful in enabling the learner to follow and judge the quality of knowledge in terms of some quality dimensions, e.g. originality and reliability. With meta-knowledge, LL users are able to grasp the whole picture of the knowledge and predict what they need to understand in the future.

3.2 People – who will learn?

Knowledge creators, knowledge administrators and knowledge users play different roles in knowledge processing. Most knowledge users, with the intention of making decisions, taking actions or solving problems in mind, are enthusiastic about learning from lessons. Therefore, users of LL are not just an audience or readers but, in more precise term, learners. Learners are not passive receivers of knowledge. LL developers should take into account the backgrounds of the potential knowledge users within a reasonable period after the launch of the LL program. In addition, LL users rarely enjoy the right or chance to discuss with the knowledge creator, not to mention to clarify the details of the context or content of the LL. Ultimately it is the users who will judge whether the LL program is fit for use.

4. Content of lessons learned

4.1 Language – how should the lesson be presented?

Texts remain the most frequently used media of explicit LL, though audio and visual materials are not uncommon. With reference to Table 1, *comprehensibility* is a dimension related to the proper use of language. *Clarity* may be another one. Whether the content of an LL is clear or comprehensible

depends on the language use. Who the users will be, as discussed in section 3.2, is crucial. Developing tips on construction safety, a choice may have to be made between words selected meaningfully from everyday language or a text full of jargon and technical terms. While the latter is understandable to architects or engineers, it may be barely comprehensible to general site workers. Suitable use of terminology is essential.

4.2 Reasons – why is the lesson valid?

LL systems may stress which practices work or fail but do not address why they work or fail. While many learning processes focus on the "what" and "how" aspects, they are not well supplemented with "why" perspective. Not only what should and should not be done and how they could be done or avoided are necessary; the reasons why past practices succeeded or failed are equally essential to improve performance and address future challenges. LL is not merely a set of strict procedures or guidelines that the users can simply follow. In order to reach informed decisions, we should not blindly follow rules and figures but should also reflect on the reasons why such choices were made in the past and why such actions were taken. This follows an old Chinese proverb: "知其然，而不知其所以然", which literally means "One knows it happened but does not know why it happened". "Why" is also crucial for providing contextual knowledge in organizational learning, as supported by the constructivist theory of learning which argues that knowledge is not just an objective thing "out there" to learn but rather a personal and social construct of meanings through interaction between people and the environment. Since curiosity is a good motivator for learning, knowing the reasons why past practices succeeded or failed is essential for encouraging users to gain and share knowledge that contributes to organizational learning. It is argued that LL should provide the rationales behind the lessons, fostering users' reflection and extension of the application of lessons to other situations.

5. An example – the Failure Knowledge Database (FKD)

5.1 Background

The FKD is a collection of LLs from failure. It has been developed since 2001, commissioned by the quasi-governmental Japan Science and Technology Agency in order to study accidents and failures in the fields of science and technology. Its purpose is to enhance safety improvement and education. The database, which is accessible to the public (available online at *http://shippai.jst.go.jp/fkd/Search*), consists of a structured repository of cases and scenarios on accidents/failures categorized into various fields. All cases share a common hierarchical structure of presentation in terms of cause, action, and result. The collection of FKD keeps growing, with new cases contributed by academics and practitioners. The developers of FKD hold that failure knowledge is not being effectively communicated. The answer to the problem is therefore the provision of a picture of how to structure failure knowledge and to ask people encountering failure to describe the case in terms of that structure (Hatamura 2005). The main idea is to present failure knowledge in a well-defined framework so that high accessibility of the cases can be achieved as well as effective exchange of knowledge. Effective communication is vital to knowledge transfer, especially in the construction industry, due to the increasing specialization of professionals.

5.2 Discussion on the quality of context and content

The FKD is rich in meta-knowledge. All its cases offer case name, data, place, field, and author, in line with the Dublin Core Metadata Element Set. The meta-knowledge helps the users of the database to decide at first sight if the lessons are interesting to them, and to speed up the searching process of relevant cases. The knowledge creators of the database are mostly professors, researchers, professionals and technical personnel. So are the target users of the database, who are expected to have attained certain educational background and be able to understand technical terms in the case details without difficulty. The content of the cases is presented in short paragraphs and points, usually in a direct and indicative style. Cases were recorded in Japanese and then translated into English, irrespective of where the incidents happened (e.g. "Collapse of the Korea Seoul Seongsu Bridge" and "Disaster of Chemical Plant at Flixborough"). In the Japanese version, there are 1,167 cases (as at 25.1.2010), while there are only 547 cases in the English version, implying that at least one half of the cases have not yet been translated.

The FKD adopts a "cause-action-result" concept in describing the structure and sequence of failure. According to the interpretation of the database, result (e.g. electrical failure) refers to the observable fact while cause is the human error (e.g. carelessness) leading to the result and action means the human intervention (e.g. missing a signal) that links the cause and result of the failure. The developers of FKD maintain that neither cause alone nor action alone will lead to failure and failure can only result when both cause and action exist (Hatamura 2005). Conceptually, the sequence of events is like this: first a human cause, followed by human action, then the result. While this "cause-action-result" sequence is simple enough to understand, this approach is not without problems -- the problem of sufficiency, which means that assuming the cause given had not been established, would the failure still occur? Simply put, there may be other causes leading to the failure. In one of the cases, "By the signal error, the train was stopped" (written by M. Kitajima, about a signal error incident happening in Yachimata, Japan, in Sep 2003), the author of the case attributes the incident to a mistake made by a train lookout man who gave the wrong flag signal. The case writer further suggested that, among other countermeasures, the experience of the train lookout man should be checked, and he should be replaced by a person with more experience. While it is reasonable to believe the result of failure was "caused" by the train lookout man's mistake, this knowledge is just about the "how", whereas the question to address should be "why". How the case writer arrived at his conclusion cannot be found in the content of the LL. It might be that the train lookout man was suffering from fatigue after having worked for long hours, or the design of platforms was defective because of unnoticed blind spots. The linear "cause-action-result" may mislead us to jump to immature conclusions and hamper users' reflection on the underlying problems.

Several claims about the authors' constraints in the discussion of FKD have to be made here. First, the analysis of the quality of the context and content of the database is based on its English version only. If there is any wrong interpretation due to translation and discrepancies between the Japanese and English versions, the errors belong to the authors. Second, without conducting a comprehensive survey on the cases, the criticisms are not meant to be generalized to the whole database. Third, the comments are based on the content of texts available, without clarification or exchange of ideas with the database administrator.

6. Conclusions

This paper describes the quality dimensions of LL with respect to two main approaches: context and content. Meta-knowledge, people, language and reasons are among the areas to which more attention should be paid.

The Failure Knowledge Database (FKD) is introduced as an example to show the evaluation of an LL. The FKD is a good example of knowledge transfer in terms of LL from failures in the field of science and technology, including the construction industry. Release of knowledge in the public domain in terms of cases of failures should be encouraged, as this kind of sharing of accidents with analysis and structured knowledge is rarely found in the world.

Lastly, it is worth noting that once the knowledge has been captured and codified as LL, the content will become fairly static. As the external environment keeps changing, the conditions when the knowledge is produced may alter and render the lessons no longer applicable, partly or fully. Hence, the LL needs maintenance which is costly and time-consuming. As an alternative, richer contextual information should be provided so that users can decide if the knowledge is to be used.

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