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Knowledge management across the enterprise resource planning systems life cycle

Daniel E. O'Leary

Marshall School of Business, University of Southern California, 3660 Trousdale Parkway, Los Angeles, CA 90089-1421, USA

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Abstract

This paper investigates the use of knowledge management to support enterprise resource planning (ERP) systems across their entire life cycle. Knowledge management can be used to support ERP system in their choice, implementation and use, both inputs and outputs. This paper summarizes a number of actual examples and discusses some emerging efforts, focusing on knowledge management, with particular interest in case-based knowledge management. A prototype system designed to support the use of an ERP system is presented.

Keywords: Enterprise resource planning systems; Knowledge management

1. Introduction

One of the largest areas of software implementation is what is referred to as enterprise resource planning (ERP) systems. Perhaps the best known of the ERP systems include those known as the ERP "big four": SAP, PeopleSoft, Oracle Applications, and J.D. Edwards. Other well-known systems include Lawson, Great Plains, and Platinum.

E-mail address: oleary@rcf.usc.edu (D.E. O'Leary).

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ERP systems are software that can integrate across multiple functional areas by focusing on processes, rather than the individual functions. At one level, ERP systems provide transaction processing capabilities that help to integrate all of a firm's transaction processing. At another level, using that transaction processing information, the firm can plan their activities, such as production. This suggests that knowledge management can be used for a range of activities, e.g., transaction processing support.

Architecturally, ERP systems generally are based on a relational database system, such as Oracle. Using a relational database and appropriate process redesign allows the firm to capture data once they are generated. Then, reports can be generated so that all users have access to the same information. This allows for "information congruence," e.g., so that each functional area makes use of the same sales forecast, resulting in fit between key areas of the firm, such as marketing and production. As a result, some knowledge management may be able to exploit the underlying information and database structure, as is seen in the prototype system developed below.

Both large and small firms have adopted ERP systems. It has been estimated that virtually all of the Fortune 500 firms have either implemented an ERP system or are implementing an ERP system. In addition, small- to medium-sized enterprises also have adopted ERP systems. For example, in 1997, roughly 35% of SAP's customers had revenues under US$200. As a result, the knowledge management needs can vary substantially across different clients.

Implementation of ERP systems has grown to be an important consulting business. During the late 1990s, it was estimated that roughly one-third to one-half of the consulting done by the major consulting firms has to do with choosing, implementing, or using ERP systems (Public Accounting Report, 1998). Further, additional consulting often is done after the ERP system has been installed, e.g., improving configuration and security. As a result, there is a large potential for knowledge management through the life cycle, both for consultants and the companies implementing the software.

ERP systems are large. As one measure of their size, Quantum's implementation of Oracle's ERP application reportedly has over 40,000 tables (e.g., O'Leary, 2000). In addition, increasingly, ERP implementations are accompanied by large data warehouses, and designed to facilitate data access and improve the reporting capabilities. Because of their size and cost, companies can benefit from substantial knowledge management efforts.

As a result of all of these developments, knowledge management systems are emerging as important tools to support ERP systems. Accordingly, the purpose of this paper is to discuss some of these knowledge management system developments across the entire ERP life cycle of choosing, implementing, and using ERP systems.

Section 1 provides the motivation for knowledge management in ERP systems and the background. Section 2 provides a brief background in knowledge management and case-based reasoning. Section 3 describes the use of knowledge management for choosing an ERP system. Section 4 investigates the use of case-based reasoning for supporting implementation of an ERP system. Sections 5 and 6 analyze the use of knowledge management for supporting the use of an ERP system, both for input and output of data. Section 7 briefly reviews the use of knowledge management by ERP vendors. Section 8 discusses the use of virtual communities in knowledge management for ERP systems, summarizing some of the advantages and limitations. Section 9 briefly summarizes the paper.

2. Background

The purpose of this section is to provide a brief background summary of knowledge management and case-based reasoning as a way of managing knowledge.

2.1. Knowledge management

Knowledge management (e.g., O'Leary, 1998, in press) includes those efforts designed to (1) capture knowledge; (2) convert personal knowledge to group-available knowledge; (3) connect people to people, people to knowledge, knowledge to people, and knowledge to knowledge; and (4) measure that knowledge to facilitate management of resources and help understand its evolution. Capturing knowledge refers to determining what information and knowledge should be added to the system. In addition, capturing can refer to creating knowledge from data where possible. Converting personal knowledge to group-available knowledge is often viewed as one of the key problems of knowledge management. That analysis can include issues such as integrating knowledge from virtual communities into a formal knowledge management system, to converting more traditional forms of knowledge, such as expertise. Connecting knowledge is aimed at facilitating assimilation and use of the knowledge. Measurement is included as another dimension that is also emerging as an area of potential interest, particularly because of the need to provide return-on-investment results and usage results to management.

This definition is consistent with how ERP firms define their knowledge management missions, considering SAP's statement. In a white paper, SAP (2000) states its mission as:

> To connect those who know with those who need to know. To convert personal knowledge to organizational knowledge.

2.2. Case-based reasoning

An important tool in knowledge management in general, and the application of knowledge management to ERP systems, as discussed in this paper, are case-based reasoning. Hammond (1988, p. 17) notes that the basic ideas behind case-based reasoning are:

> "If it worked, use it again." and "If it didn't work, remember not to do it again."

Knowledge management systems that employ case-based reasoning aim to remember what worked and what has not worked. Cases can be matched to meet needs or case-based reasoning can be used to evolve existing cases to meet emerging needs. A case-based system would try to find a case that best matches the existing problems. If there was no exact match, then the case that "best" meets that existing problem would be chosen.

2.3. An example of knowledge management using cases

If case information is to be easily captured, then its derivation needs to come from work processes. Information about a case should be gathered unobtrusively, as it occurs. Information should be reused by the person gathering the information so that high information quality is attained. As an example, consider a help desk scenario where users call the help desk, and the help desk enters or reuses information about the user and their problems to help suggest solutions (e.g., O'Leary and Watkins, 1992). By having the help desk person put the solution into the knowledge base, they can both keep track of what the user has been told and convert personal knowledge into group available knowledge. A system of capturing cases and having those cases available facilitates the connection of people to knowledge. Finally, analyzing the use of the system and the cases provides the ability to measure the use and evolution of the knowledge. For example, the growth in the number of cases provides one measure as to the growth of the knowledge management system. These same ideas are applied to a number of different settings throughout the ERP life cycle.

3. Choosing ERP systems

The need for knowledge management systems to facilitate the choice of ERP systems was illustrated in the case of Timberjack, where two US$30 million divisions recently were faced with the choice of choosing the same ERP system for two divisions, one in the US and the other in Sweden (Romanow et al., 1998). Timberjack was faced with trying to find a single ERP system that met both US and Swedish offices needs. Because they were located on different continents, sharing information was an important task. Unfortunately, much sharing was done using paper and was done in an ad hoc manner, resulting in asymmetries of information between the two divisions. As a result, not all the critical knowledge necessary was generally available in a timely manner. For example, important information contained in an article found by one of the people involved was made generally available only to the Swedish office. Later, when the US pushed for one particular ERP vendor, the Swedish group then called into the discussion information from the article.

In order to facilitate broad access to information and eliminate information asymmetries, a knowledge management system designed to capture and make available information regarding the various ERP systems in a timely manner would have been a helpful device. Such a system could have included both generic information related to each ERP system and firm-specific developments, such as requirements and other issues. Information about each of the systems under consideration could have been embedded in the system. Reports from magazines and other sources, such as Gartner, could be embedded in the system. In addition, if the system had been digital and available over the company's intranet or over the Internet, then the speed of diffusion of the information would have been more rapid and not selectively employed.

4. Implementing ERP systems

Implementing ERP systems can result in a number of issues that can benefit from knowledge management, including supporting implementation difficulties and managing system changes.

4.1. Support for implementation difficulties

Developing ERP systems requires that multiple users and developers coordinate their implementation efforts. As users and developers find problems during an implementation, they need to keep a record of those problems, in order to make sure that the problems are addressed and that solutions are found. The problems and the solutions become the cases. In some cases, users may have the same or a similar problem. If the problem has been solved, then users need to be able to find out about the previous solutions to the case. In addition to previous solutions, the knowledge base can keep track of the "who" issue: who solved the problem and what is their contact information. If the problem has not yet been solved, but others have the same problem, then there needs to be a coordination of case solution efforts because, otherwise, resources will be misallocated with the development of duplicate solutions.

As an example, as part of the development of an ERP, a "Big 5" consultant developed a knowledge base that would capture problems and allow tracking of their solutions. As noted by the consultant during an interview:

> (The system is used to)... categorize problems by issue category, e.g., training, system, network, PeopleSoft Configuration Set Up, PeopleSoft Module, etc. ...a user logs in an issue with information, such as which module, process, screen shot... (that is the source of the problem). Then, a consultant opens it to solve the problem... Any progress or resolution to an issue will be logged into this database... This way... the project can have better resource allocation planning.

Originally, the system was developed in order to provide a quick fix to track an overwhelming number of user support requests. In addition, there had been duplicate inquiries that ultimately led to redundant efforts, which the knowledge management system now minimized. As time went on, there were an increasing number of problems and solutions added to the system, resulting in a large database of cases of problems and solutions.

Future plans included changing the computing environment and migrating the system to Lotus Notes. In addition, they planned to extend the knowledge base. A case-based system is now being designed, couching the data as cases in order to more fully exploit machine processing capabilities of the cases.

5. Using ERP systems: developing data for input to ERP systems—support for financial transactions

Using ERP systems requires that the user be aware not only of how to use the system, but also of what he/she wants to do with the system. One approach is to use knowledge management to support the users.

5.1. Financial transactions

ERP financial modules require that users be able to provide transaction information for use in the system. Transactions vary in their difficulty, and some entries can be very difficult. In some cases, only experts are able to develop those entries. However, those experts may be on vacation or ill. As a result, users may not be adequately prepared to place financial entries into the system. Further, ERP systems are complex and not easy to use. Substantial training may be necessary to facilitate system use. Thus, there is interest in developing system support for other users. For example, recently, I had a conversation with a representative of one of the big four ERP firms who indicated that their firm was interested in obtaining knowledge-based support for those personnel making financial system transactions.

Unfortunately, there has been limited research to-date on formal knowledge representation of transaction knowledge to guide development efforts. Perhaps the only paper to model the knowledge-based representation of financial transactions is O'Leary and Kandelin (1992). In that paper, the authors developed a domain-specific natural language-based system that "understood" accounting language and was able to use that understanding of events in order to generate the resulting financial transaction entries. However, the system was not aimed at providing support for transaction usage.

5.2. Transaction characteristics

An important characteristic of financial transactions is that they tend to repeat themselves. For example, an overwhelming majority of a firm's financial transactions are purchases or sales. Within these two types of transactions, there is substantial similarity. The basic form of all purchases is roughly the same, including either a cash disbursement and a purchase or an accounts payable and a purchase. "Purchases" is a generic account sometimes replaced by an account representing the specific item purchases, such as materials or a particular kind of materials. This repeating nature leads us to suggest that a case-based reasoning approach is an appropriate vehicle to capture and represent knowledge about financial transactions.

5.3. A prototype system

Using the M.4 shell, I developed a preliminary system design that exploits the basic underlying database requirements for financial transactions (see Appendix A for a sample case and a few rules). In particular, research suggests that ERP systems employ a database schema that generates information on resources, events, agents, and locations from the financial transactions in ERP systems (O'Leary, 1999). As a result, the underlying database structure is used as the basis of the cases.

In particular, the Resources–Events–Agents–Location (REA/REAL) schema is used as the basis of capturing information about entries for the case library. REA (McCarthy, 1982) and REAL (e.g., Hollander et al., 1996) provide a theoretical model on which to base the system.

The initial and driving matching criteria for the cases in the systems are the events (E), which the system is designed to process. Additional information in the cases includes the resource (e.g., cash) and the direction of change in the resource (e.g., cash increasing), the external agent (e.g., the particular client), and the location for which the event is occurring (e.g., central office). In addition, the resulting financial system entry, in terms of debits and credits, also is captured. Although REA/REAL does not require a debit–credit structure, ERP systems still use that approach to get transaction information. As a result, the system is designed around a debit–credit structure.

5.4. Extensions

There are at least three directions in which the prototype can be extended. First, the system can be extended by broadening the set of variables used to characterize a case. For example, time can be added as a variable. Measures of time could include:

- When during the year did the transaction occur?
- When during the month (e.g., month end) did the transaction occur?
- When was the last time that the transaction occurred?

Second, although transactions basically "repeat themselves," they are not always identical. Additional case-based reasoning may be necessary. For example, previously stored financial transactions may need to be modified to make new transactions, and/or new transactions do not match 100% any of the previously stored transactions and thus a selection must be made based on partial match. Thus, additional cased-based approaches can be implemented in real world settings.

Third, additional support could be generated to support users of other modules, such as human resources. As part of defining case-based support for those other modules, the prototype suggests that we continue to focus on the events of concern to users, and capture case information that includes resources, agents, and locations. Further, the particular module domain may suggest other information that could be used to characterize cases.

Fourth, the developer of a transaction can note that a particular transaction was difficult and the rationale for it being difficult. That information can be fed back into the system providing another case and potentially another dimension—the cause of the difficulty, unless that dimension is already included.

6. Using ERP systems: developing data for output

Reporting capabilities for ERP systems are generally perceived as difficult to use. As a result, companies have taken a number of strategies to make the information available, including intranets and portals.

6.1. Intranets

Starting with Microsoft's implementation of SAP, there has been a push to make ERP report information available on corporate intranets (O'Leary and Markus, 2001). As a result, ERP report information increasingly is being treated as part of firms' knowledge management systems.

In the case of Microsoft, expert users were expected to use the reporting capabilities of the ERP system. However, for less expert and casual users, a wide range of information generated from the ERP was made available on the intranet. In addition, in making the information widely available, the move of information to the intranet minimized ERP costs that Microsoft incurred, since ERP system costs were based on a per-seat level of usage.

6.2. Portals

Not long after firms began to make ERP information available on intranets, ERP vendors began to release plans for portals to their ERP systems. Perhaps the best known of those portals is SAP's "MySAP.com." Others include (e.g., O'Leary, 2000) J.D. Edwards' "ActiveEra" and Lawson's portal. These portals are not only seen as vehicles for providing users with output information. In addition, they are seen as central in ERP vendor knowledge management strategies (e.g., SAP, 2000).

6.3. Data warehouses for ERP systems

Increasingly, firms are making ERP information available on their intranets. However, typically, ERP-based reports are designed for a single month, quarter, or year. As a result, some users are now interested in analyzing the available data. As a result, firms are implementing data warehouses to facilitate access to a broader range of the data over longer time periods, such as multiple years. If data are available in data warehouses, then those same data can be analyzed from a knowledge discovery perspective. Relationships between different variables can be explored and ultimately converted into usable knowledge.

7. Knowledge management at ERP firms

Each of the ERP big four firms faces substantial knowledge management challenges. First, all need to make knowledge available to their partners and clients. For example, J.D. Edwards' "Knowledge Garden" provides password-protected resources for both employees and partners. Edwards' (2001) Knowledge Garden has content in a number of areas, including the following:

- company positioning and key facts
- education opportunities
- sales and marketing
- marketing
- partners, and
- product information, including downloadable material.

In addition, the ERP companies provide products to their customers to facilitate knowledge management. For example, SAP (www.sap.com) focuses its knowledge resources on two products aimed at different types of knowledge, unstructured and structured. SAP's "Knowledge Warehouse" is aimed at managing unstructured knowledge and delivering it to those who want or need that knowledge. That knowledge includes much of the information available from SAP's web site, such as business knowledge (data, processes, and models), product knowledge (R/3 functionality), training materials, and documentation, in a program that grew out of their "Advanced Training Solution." SAP's Business Information Warehouse, a data warehouse, is used to manage structured data, typically generated from the ERP system.

8. Virtual communities for questions across the life cycle

Virtual communities centered around the Internet or company intranets can provide a vehicle to generate knowledge across the entire ERP life cycle. Virtual communities provide informal settings where participants ask questions of other participants in the community. It is not unusual for such communities to be available for virtually all of the major ERP packages, with questions about packages occurring about the package across the entire life cycle. Participants to the list post questions to the list hoping that some other participant will know the answer or where a solution can be found. Other times, participants say what actions they took and ask if anyone knows what went wrong.

In contrast to potentially huge vendor web sites, the advantage of such lists is that they accommodate specific questions. Oftentimes, the responses are to the point and timely. Further, once a participant responds to a particular question, that can allow a dialogue between the asker and respondent.

However, there are some limitations of such lists. Unfortunately, knowledge can get lost to the list. In some cases, participants provide a personal e-mail address for responses. Once a respondent has posted an answer to a question, there is always the chance that further communication will be taken off the list. Further, not all questions are answered or not all questions are answered in a timely manner. In addition, there is no guarantee as to the quality of the answers in most virtual communities. As a result, not all questions necessarily are answered correctly. Finally, the same question can be asked again and again, as participants attend to the list and then drop away from the list. Unfortunately, although there may be frequently asked questions, there is often no one tracking those questions or accumulating those lists.

Virtual communities can be very helpful for the vendors, not just the users. User problems can provide feedback for system design. Further, vendors can have personnel monitor those lists responding to the hard to answer questions.

9. Summary

ERP systems are receiving widespread use. Knowledge management is being used through the entire life cycle to support client and consulting efforts. This paper has focused on knowledge management for choosing, implementing, and using ERP systems. In particular, a prototype system design was presented for using case-based knowledge about financial transactions. However, knowledge management systems could also be developed for other aspects of ERP systems, such as designing, developing, maintenance, and testing.

Although this paper has addressed some important issues, it is just the beginning. There are a number of other issues integrating ERP systems and knowledge management. Organizational learning is becoming increasingly coupled with knowledge management. As a result, it is important to analyze how ERP systems can facilitate organizational learning and how organizational learning can be built into ERP systems. In addition, rather than focus on using knowledge management on portions of the life cycle, research could focus on more systematic efforts across the entire life cycle.

Further, research could focus on devices designed to facilitate knowledge management within or between organizations. For example, a number of virtual communities have been developed to solicit and generate knowledge about specific ERP packages, such as SAP or Oracle. Research could be designed to better understand the existence, contribution and continuity of such communities.

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Appendix A

Exhibit 1

```
/*----------------------- object class definition ----------------------*/
classdef(entries) = [
  supers = []
].

/*----------------------- class instance of entry event cases -----*/
instdef(sales_event) = [
  class = entries,
  event_category = sales_event,
  resource_increasing = cash,
  location = central_office,
  external_agents_impacted = customers,
  debit = cash,
  credit = sales
].
/*-----------sample goal, questions, legal values and rules--------------*/
goal = [final_conclusion].

question(event_category) = 'What category of entry are you considering?'.

legalvals(event_category) = [sales_event, purchase_event].

question(status) = 'Would you like to continue considering case
attributes?'.

legalvals(status) = [continue, all_done].

if event_category = Category and
   classinst(entries, ENTRIES) and
   ENTRIES <- getslot(event_category) = Category and
   ENTRIES <- getslot(resource_increasing) = C and
   display(["Found a resource increasing-based match for ",C,nl])
then conclusion_match = good.

if event_category = Category and
   classinst(entries, ENTRIES) and
   ENTRIES <- getslot(event_category) = Category and
   ENTRIES <- getslot(event_category) = D and
   display(["for a ",D,nl])
then event_conclusion = good.

if conclusion_match=good and event_conclusion=good and status=all done
then final_conclusion=good_match.
```

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