Case-Based Reasoning Support for ERP Pre-Planning

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Abstract

A project planning is one of the most important processes that determines success and failure of the project. A pre-project planning is also essential job for information system implementations at the early stage of project planning, especially for management information system like ERP.

However, pre-project planning is very difficult, because lots of factors and their relationships should be considered. Pre-project planning of ERP implementation has been done by project manager's own knowledge and experiences.

In this article, we propose a system that help project manager to make a pre-project plan of ERP project with case-based reasoning(CBR) framework. The proposed CBR system saves previous cases of ERP pre-project planning in the case base. Then, the system finds the best similar case with the current pre-project planning problem. Project manager can make a pre-project plan by adjusting the most similar case.

From the interview with project managers, we collect some field cases of ERP implementation. We organized these cases by using XML(Extensible Markup Language), which is good for representing hierarchical information. XML gives us some flexibilities to correct and maintain cases. We make a prototype system, PPSS(Project Planning Support System) that help project manager to make a pre-project plan of ERP implementations.

The object of the system is to support project manager to make a pre-project plan of ERP. We hope the result of the study can be applied to other information systems. Our research should be extended to cover other stages of project planning.

Keywords:

ERP, Project Planning, CBR, XML

Research Background

In the late 1990's, several articles have reported failure and budget run-over of enterprise resource planning (ERP) projects, and some of them analyzed what have made the ERP implementations more risky [Ross(1999), Krasner(2000), Hawking(2003)]. Ross(1999) asserts that characteristics of ERP projects are far different from those of previous information system(IS) projects in a sense that ERP project is a kind of BPR(Business Process Reengineering) and it involves changes of individual line of work, business process, and even company organization. Krasner(2000) stresses management problem of ERP project such as integrated project team planning, a formal decision-making, managed communication and top-management involvement. Especially, he suggested applying lessons learned from earlier implementations to later implementations. Hawking(2003) proposed that ERP project is a large scale complex information system and requires careful planning of time and budget to avoid project disaster. Due to those potential risks, some companies who have a plan to introduce an ERP system hesitate to invest large money into ERP implementation project. In short, ERP project is complex, project management is more critical than software development efforts, and its impact into organization is usually huge, so more careful project planning is highly recommended.

Relative to the other phases in information system (IS) project life cycle, the importance of the initiation phase has been emphasized by many field practitioners and academic researchers. It has been demonstrated that a poor planning takes more time and workforce afterwards, and this phenomenon is usually getting worse as time goes by. Poor project planning is revealed as one of the most common factors of IS project failure [Kadoda(2001), Yeo(2002), Whittacker(1999), Dvir(2003)], and Dvir(2003) showed positive correlation between project planning efforts and project success. ERP projects, a kind of IS project, are no exception.

Buy the way, project manager cannot take much enough time for scoping and planning in the initiation phase, because management often presses project manager to start project work instead of spending time to generate a project detail plan [Wysoski(2001)]. At the initiation phase, management wants to know resource requirements for ERP implementation approximately not with exact figures. One of the most effective ways for project manager to persuade management is to show real figures of previous projects of companies in the same industry and similar size. He could somewhat justify his project plan (resource plan, time plan, man-month plan, project team plan, implementation methodology) with previous projects information. But project manager has got no systematic support for the planning, and has no choice but to depend upon his own experiences and knowledge. Project manager's individual experience and knowledge is, however, very confined and unorganized, so it is hard to apply in systematic manner.

There have been two supporting tools for project manager's planning job. One is a project management tool like PERT and COCOMO model that help making activity plan and estimation of project effort, respectively. However, both are not suitable for the early stage of IS project, because they require quantified data to generate detailed activity plans and exact estimations. The other is a knowledge management system that stores previous project implementation experiences into knowledge base and provides information from the knowledge base to project managers with search-based manner. Though knowledge management systems can serve useful information, applying searched information to the planning job is another matter. In other words, making a pre-plan is still done by project manager's artwork.

Case-based reasoning (CBR) is a research paradigm in machine learning, which has been well applied to the problems with success and failure cases and hard to find analytic solving heuristics. CBR system is based upon the idea that previous solutions, whether successful or not, can provide a well-enough solution to the current problem. Unlike knowledge management systems, CBR system can generate a solution by adaptation of previous solutions.

We suggest that CBR can be well applied to ERP project pre-planning problems: ERP project sizing and resource estimation. Project pre-planning is usually done at the end of 'Scope the project' and before 'Developing project plan' which means full-out undertaking of project (Figure 1). At this time point, management wants to know pre-planning results: rough estimation of resource requirement for project. Since 1990's a plethora of companies have implemented ERP, we could get good enough cases to use in CBR for ERP project pre-planning.

We developed a prototype system PPSS (Project Pre-planning Support System) using CBR approach for ERP project manager's pre-planning job. Case base of PPSS is organized by XML(eXtensible Markup Language) framework, which is flexible to manage case content and compatible with Internet environment. 4 R's of CBR reasoning cycle: retrieve, reuse, revise, retain of cases are

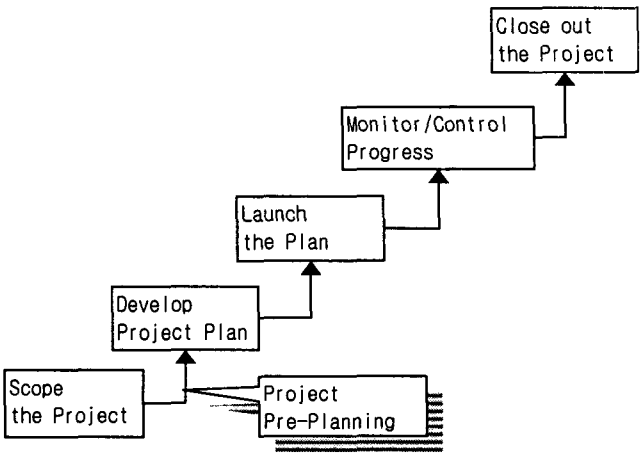

Figure1 Project Development Life Cycle

performed in PPSS with ASP and Visual Basic program. The PPSS would be helpful for project manager of companies implementing ERP and contractors who are usually IT consulting firms like PWC, EDS, Accenture, etc. Theses consulting firms can garner their ERP project experiences and knowledge.

The remainder of paper is organized as follows. The next section describes the related researches: CBR applications to IS or ERP planning. In section 3 and 4, we explain how to organize cases of PPSS by using XML and reasoning process of PPSS to generate a plan. Section 5 considers contributions and further researches.

Related Researches

CBR is a generic methodology and has been applied to many problems in diverse areas such as medical diagnosis, engineering product sales, manufacturing process planning, electromechanical device design, robotic navigation, to mention but a few. [Aha 1998][Watson 1999][Marling 2002]

The use of analogies for IS project have also been suggested by many researchers and successfully applied. Grupe (1998) explored CBR as a mechanism to improve software development productivity and quality at each stage of software development process: requirement definition, effort estimation, software design, troubleshooting, and maintenance process. Among software development stages, effort estimation is one of the most frequently mentioned issues since Boehm(1981) suggested at first. [Boehm 1981] [Kadoda 2001] [Mendes 2002] Mendes(2002) applied CBR to Web project cost estimation. However, there is little attempt to apply CBR to ERP project planning jobs.

Table 1 – CBR Applications to IS Project

Author	Domain Problem	Contribution
Finnie (1998)	Software development processes	-Application exploration
Jadoda (2001)	Software project effort prediction	-CBR configuration for application
Mendes (2002)	Web project cost estimation	-CBR configuration for application
Kwon (2003)	ERP project	-CBR configuration for application -XML-based case organization -Rule driven adaptation

The previous researches also had some contributions of providing us what are the parameters to be considered and how to configure CBR application for the IS project. Such decision parameters include feature subset selection, analogy adaptation, and similarity measure selection. In this paper, we describe how to configure these decision parameters for ERP pre-planning problem in PPSS. Other contributions of PPSS at table 1, XML-based case organization and rule driven adaptation will be explained in section 3, and 4.

Case Base of PPSS

In this section, we explain the process of building a case base and the structure of a case base. And we describe what XML-based case structure's benefits are.

First, we select attributes that form a case. A case is usually a collection of attribute value pair. Factors those are important for ERP project manager in pre-planning stage should be included as attributes. Attributes are categorized into two groups: company characteristics and project determinants.

Project managers want to examine previous ERP project experiences of other similar companies, so company characteristics play a key role for searching similar cases in reasoning process. And resource requirements for ERP project changes according to company characteristics like size, business type, etc.

Company characteristics have three categories of attributes: company general facts, information system and ERP requirements. Figure 2 shows the structure of company characteristic factors. Company general facts include business type, size, revenue, number of employees, process complexity. Information system category includes legacy system information and company's intimacy level of information system. If a company has legacy systems and want to use some of them, project manager should

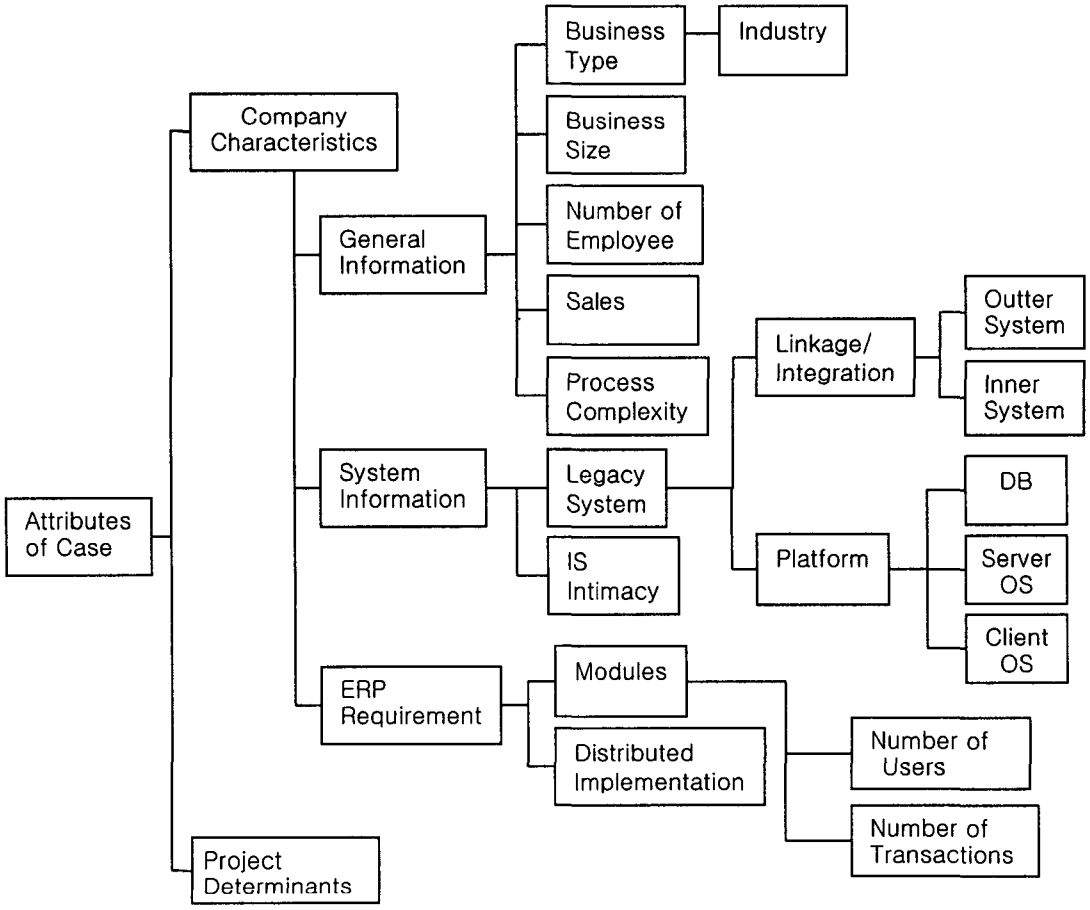

Figure 2 Company Characteristic Attributes

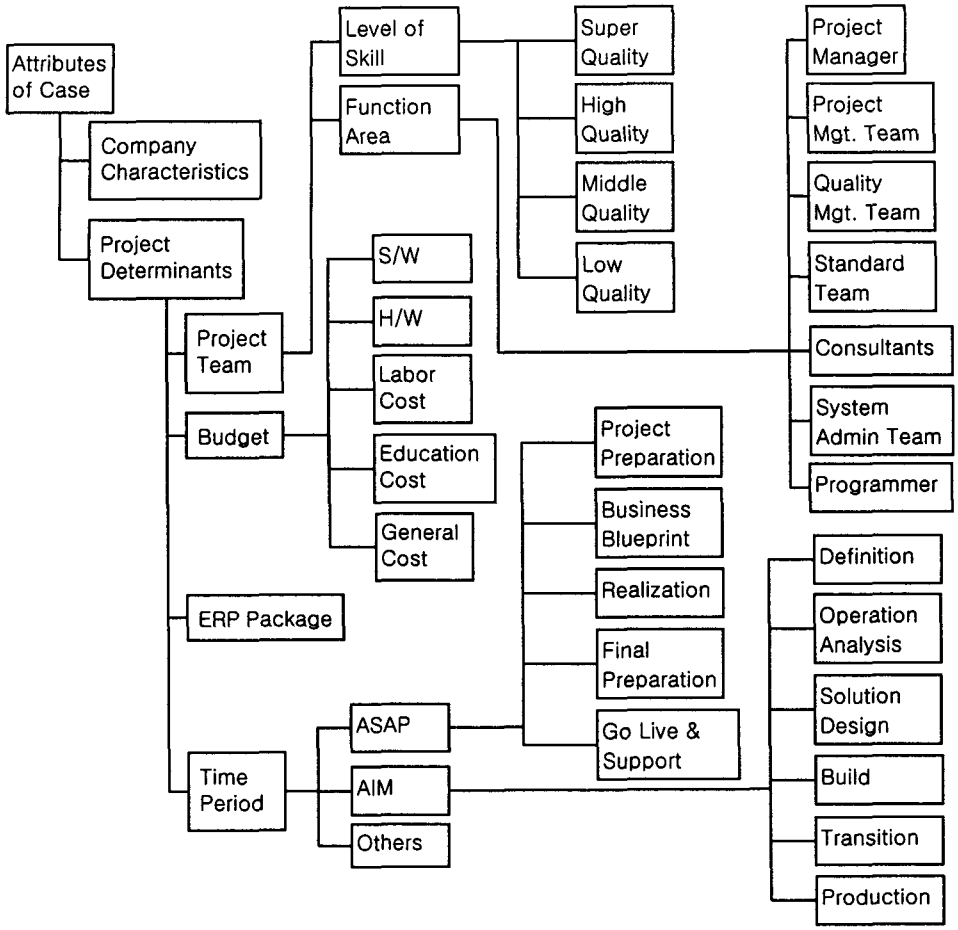

Figure 3 ERP Project Determinant Attributes

recognize them as systems to be linked or integrated with ERP. As legacy system integration or linkage often become a technology-barrier and time-consuming job, how many this kind of legacy system exists and integration level are significant for ERP implementation. ERP requirements include modules of ERP to be implemented with number of users and transactions and distributed ERP implementation according to geographic locations or business divisions.

Second group of attribute is ERP project determinants, which are of resource invested to complete project such as project team, budget, time period, and project management methodology. Project manager can guess resource requirements for his own project from this information. Figure 3 shows the structure of ERP poject determinant attributes.

Companies typically do not give much thought as to how the project teams should be structured. And team structure varys tremendously from company to company and situation to situation. [Anderegg, 2000] Therefore, project manager's one of the most pressing jobs in the early stage is building project team. Project team is usually organized with functional areas for project. But project manager should consider team member's level of skill, because project labor cost depends largely upon skill level of ERP consultants, programmers, and other members. Project budget is a management's top concern, and project manager needs previous project's budget items and their allotments. Project time varies according to resources put in and project scope. Should a company expand the scope of ERP implementation, then it will increase the time or other resources. And project time period decreases, as more man-month input. The information of how much time spent at each stages of project life cycle is another concern and helpful for project manager. Project management methodology is also project manager's concern. Most ERP package vendors have their own ERP implementation methodology, so determination of ERP package means selection of ERP implementation methodology. Each methodology has 4 to 6 stages, and time period of each stage will be a good reference for project manager.

For the organization of a case structure, we have explained 'what', which factors to form a case. Most of the factors are derived from articles of ERP-related magazines and journals, and we elaborate by interviewing with experts who have been an ERP project manager.

Next thing is how to organize a case base. We use XML (eXtensible Markup Language) framework to represent and organize a case base. Benefits that XML framework provides are flexibility to organize and re-organize case structure, independence between content and representation,

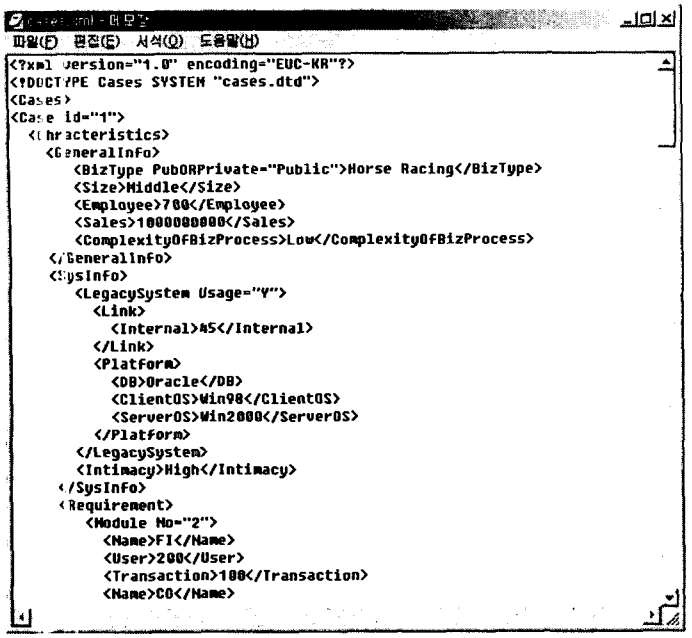

Figure 4 A Case Represented with XML

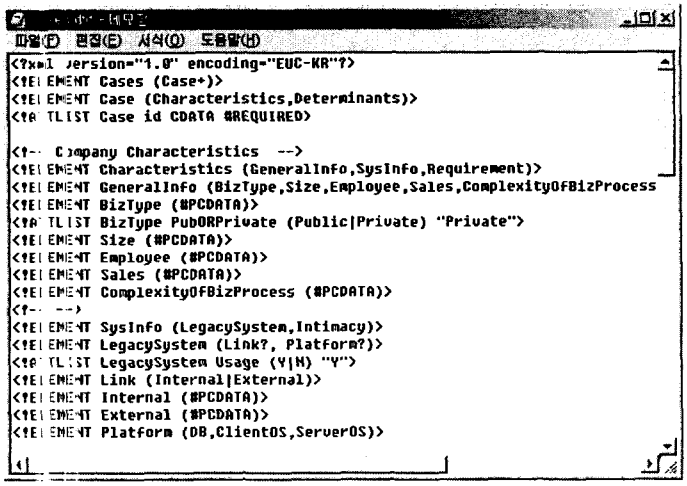

Figure 5 DTD of Cases.xml

easiness to search data from case base, reusability by modulizing case base. As data organization of a case usually has a hierarchical tree structure, XML is one of the most suitable framework to both organize and represent a case. Abidi(2002) has showed that electronic medical records are well transformed into XML format and used as a case for medical diagnostic system. Medical records usually include multi-media information and those are one of the most complex structures. In order to organize a case, we use DTD(Document Type Definition) of XML. DTD is a declaration of data structure, a kind of metadata. When a new case is created, XML parser check the data structure of new case whether it is accord with structure definition of DTD. For representation of a case, we use XSL (eXtensible Stylesheet Language), a kind of transformer XML contents into a well-formed format for Internet browser. Figure 4 and Figure 5 show a part of XML content and DTD of a case respectively.

Reasoning Process of PPSS

Reasoning process of PPSS follows the general process of CBR: retrieve, reuse, revise and retain. Figure 6 shows the reasoning process of PPSS. In order to retrieve the most similar case, a project manager should input facts about his problem, ERP project pre-planning. Company characteristics in Figure2 are major information to be input into PPSS.

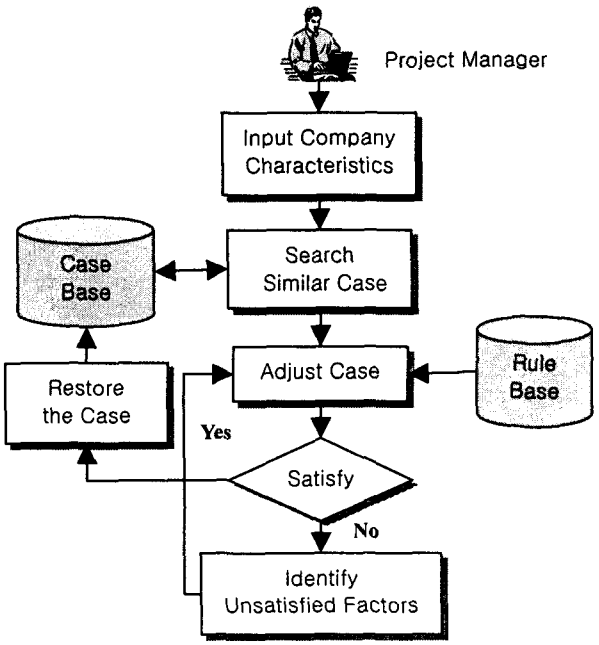

Figure 6 Reasoning Process of PPSS

Based upon input information, PPSS retrieves the similar case by using the nearest neighbor algorithm. Among cases in case base, the case with the biggest similarity index value is selected as the most similar case. The following is a formula for computing similarity index value in PPSS with the nearest neighbor algorithm.

$$\text{Similarity (T, S)} = \sum_{i=1}^{N} f_i(T_i, S_i) * w_i$$

$$f_i = \begin{cases} Min(T_i, S_i)/Max(T_i, S_i), & \text{if i attribute has numeric or scale value} \\ 1, & \text{if attribute i has descriptive value and } T_i = S_i \\ 0, & \text{if attribute i has descriptive value and } T_i \neq S_i \end{cases}$$

T: Target case, S: Source case

N: number of attributes, i: i^{th} attribute

f_i: similarity function for attribute i, w_i: importance weight of attribute i

For numeric and scale value attribute, we adopt comparative magnitude of two values as similarity function. The function can give a normalization effect to numeric

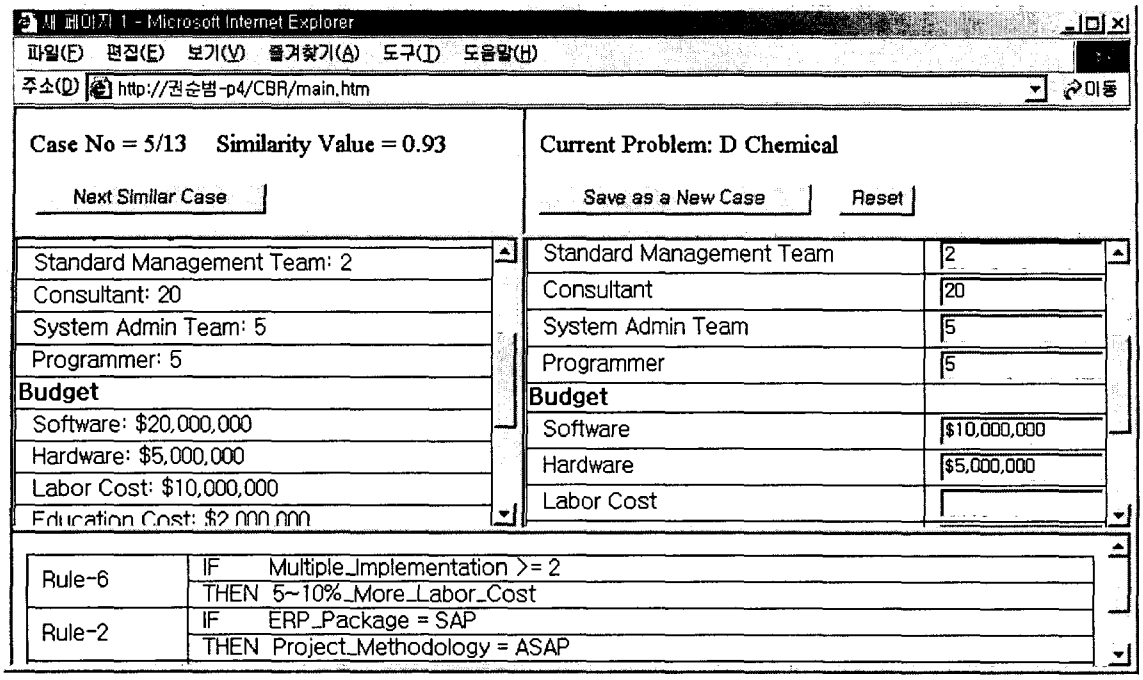

Figure 7 Case Adjustment Screen

value attributes with different scales. For descriptive value attribute, we adopt zero or one dichotomy function: 1 if two values are equal and 0 otherwise. Weight is applied to reflect comparative importance of attributes. Most interviewee replied that 'business type', 'decentralization', 'number of ERP modules introduced', 'transaction volume', and 'ERP package' are more important factor than the others. Therefore, we put double weight to 'decentralization' and triple weight to 'number of ERP modules introduced', 'transaction volume', and quadruple weight to 'business type' and 'ERP package'.

Then, we need to adjust the selected similar case to the current problem. PPSS system has a rule-base which contains knowledge for ERP pre-planning. For example, 'If ERP is implemented at the multiple places and to be integrated, cost for consulting manpower usually rises by 10 ~ 20%.' There exist some causal relationships among attributes and we can get knowledge of this kind during interview with project managers who have experiences on ERP projects. PPSS display the relevant rules to project manager when he adjusts and determines attribute values by himself. We can also make PPSS to adjust the similar case automatically, that means rule-based reasoning is started not by user but by PPSS. But for the most pre-planning job, human judgment is major role and rule-based knowledge just supports human judgment like most rule-based systems. Figure 7 shows the screen shot of case adjustment. At the bottom, you can see the relevant rule associated with the attribute that the cursor points.

Marling et al.(2002) surveyed CBR integrations with other methodologies such as rule-based system, constraint satisfaction problem solving, genetic algorithm, information retrieval. They gave several example hybrid systems of CBR and rule-based system, but two systems were in equivalent position for problem solving. PPSS uses rule-based system as a case adjustment tool, a part of CBR in order to help project manager adjust the attribute value, one of the most difficult manual jobs.

According to the general CBR process, the adjusted case is restored into case base as a new case. However, PPSS stores the adjusted case as an 'in-progress case' which means the case should be readjusted with the real figures at the end of ERP project. So, cases in progress status are excluded in default, when PPSS retrieves similar case. When a new case is stored in case base, the case representation follow XML format defined by DTD.

Conclusion

ERP is one of the most important information systems for corporate, so whether ERP project succeed or not is crucial for corporate. Recent articles have reported the failures of ERP projects, and poor project planning is surveyed as one of the main reasons for failures. Project pre-planning is far more important for ERP project, because ERP project is not a matter of software development but a matter of project management such as business process reengineering, change management, project team making.

For project pre-planning, project managers have not been provided systematic tools, and they have been usually dependent upon their own experiences and knowledge. But the helpful information for project managers for pre-planning is facts about previous projects of other companies with similar size and industry. From previous projects, we can get good enough helpful information for planning such as budget, engineers needed, etc.

We proposed a framework that supports project manager to

pre-plan ERP project by using case-based reasoning method, which retrieves the most similar previous case from the case base. A prototype system PPSS is implemented for pre-planning ERP project. Two things are methodological improvements from normal case-based reasoning. First, we adopt XML scheme as representation and organization tool for case content. Case structure can be easily re-organized by DTD, and represented in the web environment without change of case contents by XSL. Second thing is hybrid framework of case-based reasoning and rule-based reasoning. We adopt rule-based reasoning as an adjustment tool of the selected case. By using rule-based reasoning, we can systematically help PPSS users to adjust case, which is the most difficult job in case-based reasoning.

The more cases does PPSS store in case base, the more feasible solution PPSS provide. Current PPSS is a prototype system with less than 8 cases in a way that shows the proposed framework. So PPSS needs more cases stored in order to help ERP project in the field. Another thing to be stored up to meaningful level is knowledge of ERP project, which is in form of rule in PPSS. Production rule is very useful to represent ERP project knowledge and helpful in case-based reasoning. In order to give more expressiveness and smooth adjustment, constraint representation and constraint-based reasoning would be introduced in PPSS.

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