KNOWLEDGE-BASED PROCESS MODLEING IN BPR: A CASE-BASED REASONING APPROACH

Sang-Il Kim[1], Jae Kyeong Kim[2], and Soung Hie Kim[3]

[1]Graduate school of management, KAIST, sikim@kgsm.kaist.ac.kr
[2]Department of Management Information Systems, Kyonggi University, jaekkims@chollian.net
[3]Graduate school of management, KAIST, seekim@kaist.ac.kr

ABSTRACT

This paper presents a knowledge-based methodology for process modeling and its improvement that uses a case-based methodology to assist its users in the modeling and redesign of critical business processes. We developed a CAPS (CAse-based Process modeling Supporting system) to support our proposed methodology. To reengineer a new business process problem, CAPS uses a hierarchical indexing method for efficient case retrieval, and provides similarity measures for accurate case matching. Using the transformational knowledge of a retrieved case, CAPS helps BPR team to build an AS-IS model and alternative TO-BE models for the current process with ease. An order-taking (import) process in a trading firm is explained as an illustrative case study.

KEYWORDS

Process Modeling, Case-Based Reasoning, Business Process Reengineering, Trading process

1. Introduction

Business process reengineering (BPR) projects usually involve defining business objectives, identifying processes to be redesigned, understanding existing processes, identifying information technology (IT) levers, and building a prototype of the redesigned processes (Davenport, 1993). Process modeling is one of the most commonly used techniques in many system analysis and design, and BPR project because it is well appropriate to understand, measure, and document business processes (Curtis, Kellner & Over, 1992; Davenport, 1993). Building redesigned processes typically includes attempts to transform a current "AS-IS" process model (i.e., pre-redesigned model) into a redesigned "TO-BE" process model. A number of studies report that while the analysis of an AS-IS model is relatively scientific, objective, and easy to proceed, the design of a TO-BE model and implementation require much more efforts than the words' meaning (Davenport, 1993; Ku, Suh & Tecuci, 1996). Also, the immature BPR-specific tools and methods in process analysis and implementation resulted in the failure in many BPR efforts (Martinsons, 1995).

This paper presents a knowledge-based methodology for BPR that uses the case-based reasoning (CBR) paradigm to assist its users in the modeling and redesign of critical business processes. As a process modeling tool, event process chain (EPC) diagram is used in this research for representing the business process. EPC diagram is easy to read and understand for end-users, managers, and BPR experts through the elegant abstraction mechanisms and a small number of modeling constructs (Kim, 1995). To implement our proposed methodology, we developed a case-based process modeling supporting system (CAPS).

To reengineer a new business process problem, CAPS retrieves from its case base a case that is most similar with the current BPR project. Using the AS-IS model, TO-BE model, and transformation knowledge of the retrieved case, CAPS enables BPR team to build AS-IS models and TO-BE models for the current process with ease. It uses a hierarchical indexing method for efficient case retrieval, and provides similarity measures for accurate case matching. Through the transformational knowledge in the retrieved cases, we earn the building-block activities as basic elements for generating a new business process. For the adaptation of retrieved case to the new BPR project, a heuristic procedure is suggested to generate a new business process. Such an integration of CBR and heuristic knowledge provides a systematic procedure to retrieve past cases quickly and accurately, and to effectively generate alternative business processes using past expertise of BPR.

2. Backgrounds

Process modeling

Many researchers and practitioners suggested a lot of heuristics for generating alternative processes in performing the BPR. The seminal works such as Hammer(1993) and Davenport(1993) shed light on the clean slate approach as a searching method for a new business process. They proposed the brainstorming for generating creative thought from the scratch in generating alternative process models. While the expert on the BPR has much experience about the BPR, the novice and the domain experts do not have enough experience for BPR.

While some BPR projects are conducted from the scratch, others have been generated from the benchmarking of the world-class company in their industry or similar processes in different industry. Using the benchmarking technique, BPR team applied the prior experiences of generation of new process to their current BPR project. The specific methods and tools providing heuristic knowledge to be reusable could be complemented in the generation of the creative and acceptable ideas in the BPR process.

Ku et al. (1996) has suggested adopting a CBR approach to retrieve similar BPR projects for the current process. They lack a clear definition of similarity for case retrieval and the systematic procedure in the adaptation process, but their research is evaluated as a starting theoretic approach. We have suggested a systematic procedure for supporting a process modeling in BPR, and applied to the purchasing process in R & D institute [Kim et al., 1999]. In this paper, a CBR approach is presented to effectively store and apply the past experiences and expertise of human problem solvers for developing new business processes [Maher & Zhang, 1993; Pearce et al., 1992].

EPC diagram modeling

EPC diagram has been used to define a cross-functional business process of what an organization does in customer-oriented perspective (Kim, 1995). EPC diagrams are reported to be well suited in supporting BPR projects (Kim & Kim, 1997; Kim & Kim, 1998). An EPC diagram is composed of the following four constructs: event, process, branching, and flow. With these constructs, it represents a core context where business processes are frequently spread over functional boundaries. In EPC diagram, the organization's critical business processes are represented over both geographical place as well as dynamic time dimensions, and exclusively from the customer's perspective. Through the elegant abstraction mechanisms and a small number of modeling constructs, EPC diagrams are easy to read and understand for end-users, managers, as well as for IT professionals.

3. A Case-based Process Modeling Support System: CAPS

CAPS is developed to support our proposed methodology for business process modeling and to facilitate the BPR process using CBR as a reasoning mechanism [Kim et al., 2000]. Our methodology provides two phases to solve a redesign problem. The first provides an access to previous experience of BPR project case that is most similar to current BPR project. The second is about the development of alternative TO-BE models through case adaptation, which generate alternatives of process design solution when a part of the retrieved process model is relevant to the current AS-IS model. Fig. 1 depicts the procedure of generating a TO-BE process in CAPS.

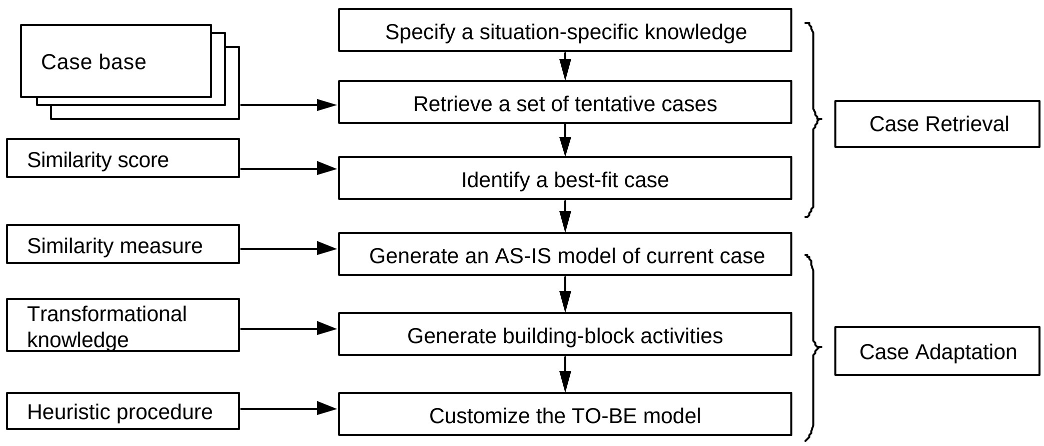

Figure 1. A procedure for process modeling through CAPS

CAPS is able to aid in the acquisition and analysis of appropriate information for process modeling. To retrieve a similar case to a current BPR project, BPR team identifies values that describe the current BPR project, such as BPR project constraints, objectives, and etc. Once the current BPR project is interpreted into a case format, the CAPS retrieves a best-fit case using search algorithms from the case base. The result of the retrieval process is a best-fit case, is composed of a set of process models (i.e. AS-IS models and TO-BE models), and descriptive-typed transformational knowledge.

Based on the best-fit case, we are able to develop the AS-IS model and the TO-BE model of the current process. If CAPS can not find any similar case, it asks the user to provide directly an AS-IS model, an EPC diagram for the current problem. Otherwise, the building block activity is applicable in that sub-parts of a current AS-IS model are discovered in the retrieved cases. The building-block retrieval using the transformational knowledge breaks the retrieved case solution up into reusable building block activities. Then, they are transformed into partial solutions of a new business process to satisfy the objectives of the current BPR project. These building blocks are collected and later used in composing the TO-BE process model. Consequently, CAPS generates an initial TO-BE process model by exploiting such knowledge as past BPR projects, process models, and transformational knowledge. This enables the user to customize the business process, and observe all alternatives in TO-BE process model caused by the customization.

Architecture of CAPS

CAPS consists of five main modules and a case base for storing past BPR cases. The modules are *User Interface, Situation-Specific Knowledge Interpreter, Case-Based Reasoning Engine, AS-IS Model Constructor, and TO-BE Model Constructor.* Fig. 2 shows the system architecture of CAPS and the inter-relationships among these system components.

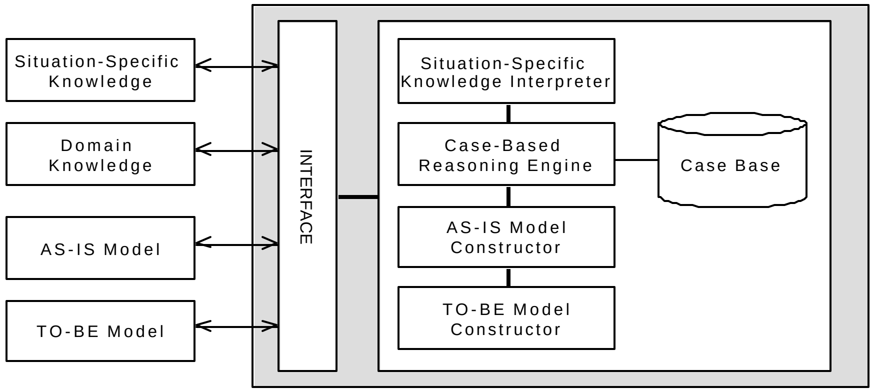

Figure 2. The architecture of CAPS

The *User Interface* module provides interactive question and answering functions. It asks the user for specific information of the current BPR project, presents the best-fit case, and finally shows the business process models (i.e., AS-IS models and TO-BE models). The *Situation-Specific Knowledge Interpreter* transforms a user's understanding of the BPR project into a frame-typed knowledge representation for the retrieval of a similar case from its case base. The *Case-Based Reasoning Engine* selects a similar case in the case base. The *Model Constructor* module takes a relevant case and performs modeling actions using the retrieved case. A detailed description of the case base is explained at the next section.

4. An Order-taking (import) Process Example in a Trading Company

The case study discussed here refers to a business process modeling procedure undertaken by a trading company (here designated ABC Ltd.) in Korea. ABC Ltd. has a headquarters in Seoul and many overseas branches in several foreign countries. Although the trading business is complex and volatile, it includes the three configurations of business: import, export, and triangular trading. To demonstrate the retrieval and adaptation process in CAPS, we take an order-taking process in ABC Ltd. with certain specified requirements. The manager expects that the BPR project accomplishes two objectives such as to reduce time and to improve customer service. Based on this BPR project specification, we present step by step the retrieval and adaptation process in CAPS.

Retrieval of a best-fit case

The retrieval process has two phases for searching similar BPR cases for the current BPR project: a hierarchical tree search and the simple scoring method. CAPS classifies the set of past cases into a hierarchical structure with respect to three attributes: industry domain, BPR project budget, BPR project duration constraint. Past cases having the same values in the three attributes are located in the same leaf node of the hierarchical tree. The initial criteria consist of BPR project budget and BPR project duration constraint, which are important attributes in a case structure. Initial criteria prune the irrelevant cases, then case retrieval process extracts cases that have same values of BPR constraints with the current process, called as tentative cases. The role of this step in the early stages of the retrieval is to prune the potentially large number of case alternatives.

After obtaining the tentative cases from the case base, CAPS carries out a second search. For such a purpose, we established a similarity score to determine the degree of similarity between a current BPR project and past cases. A similarity score of each tentative case is calculated as the number of matching objectives for BPR with the current BPR project. We called a case that has the highest similarity score as a best-fit case.

AS-IS model construction

An adaptation process in the AS-IS model construction process is composed of two sub-steps: identifying the relevance of the best-fit case on the current process and modifying the best-fit case for the current process. To identify the relevance, CAPS asks a user to provide the specific information of the current AS-IS model. The criteria for checking the relevance are as follows: type of process, process owner, participants in the business process, and activities of each participant. After the system gets the specific information, it calculates the similarity between retrieved AS-IS model and user's answers. Based on the AS-IS model of best-fit case, the BPR team has to modify it according to the following steps.

Step 1. Identify stations involved in the current AS-IS process.

Step 2. Identify activities (i. e., processes and events) in each station.

Step 3. Identify relationships (i. e., precedence and branches) between activities.

Step 4. Draw the business process according to the flow of customer's requirement and EPC diagram guidelines.

In general, business process in ABC Ltd. has four phases from the trading planning to follow-up service. In the first phase, employees in headquarters gather various kinds of information such as buyer or seller companies, merchandise, and market trends, etc. They offer plausible customers available information about merchandise, which is possibly necessary to buyer companies. Otherwise, buyers inquire products that they need. In the second phase, ABC Ltd. makes an offer that includes detail specifications of a transaction such as product specifications, price, delivery date, and payment type, etc. Sometime both companies negotiate the detail specifications of the transaction. When both trading parties agree to a transaction, they make a contract. In the third phase, ABC Ltd. delivers the ordered merchandise to buyer. In delivery process, many organizations such as banks, transportation company, insurance company, and the customs. This process is somewhat structured in the way of using EDI. Finally, ABC Ltd. performs a follow-up service. When buyers complain with the plausible problems, ABC Ltd. manages them.

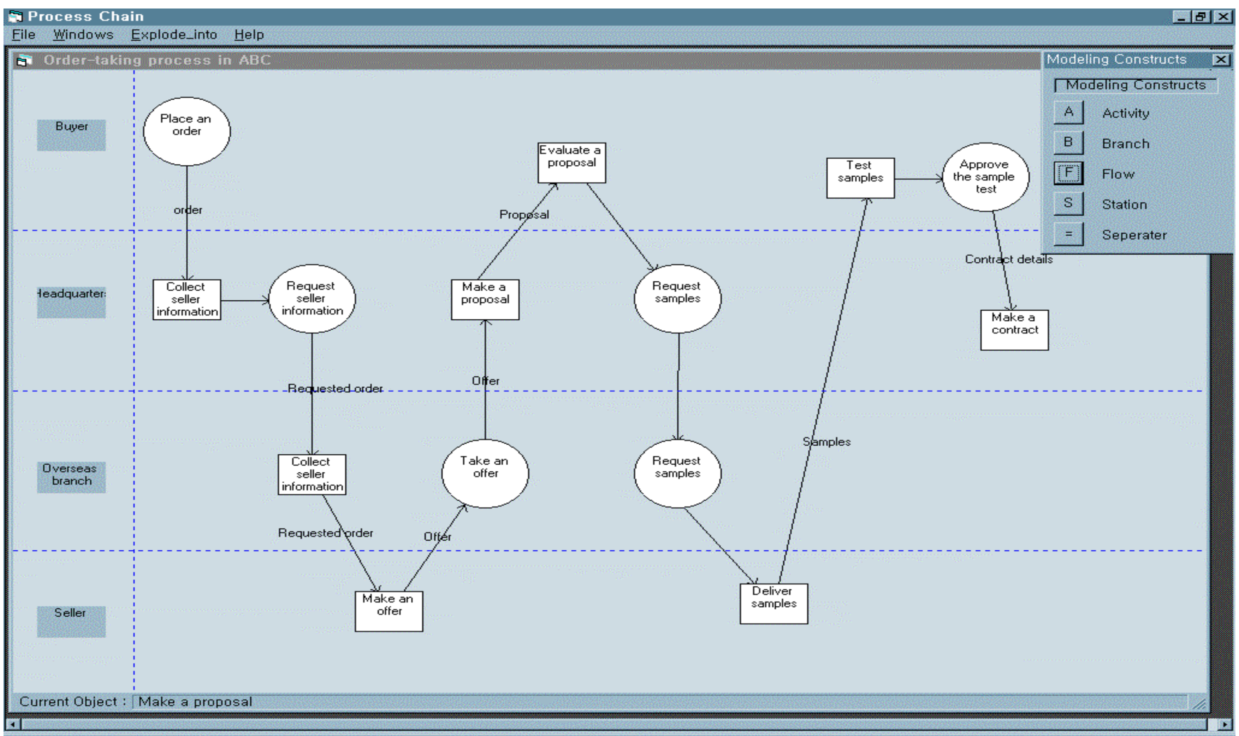

Figure 3. An AS-IS model for the current process

In our example, the order-fulfillment process in the manufacturing firm is retrieved from the case base. The order-taking process in a trading firm is somewhat different from that in a retrieved case. The trading business process has many characteristics. First, each transaction includes the exchange of goods, services, and funds among multiple parties such as the buyer firm, the headquarters office, the overseas branch, and the seller firm. Therefore, BPR team adds a new STATION 'overseas branch' and a new PROCESS activity 'collect buyer information' into the retrieved AS-IS model. Second, the oversea branch acts as an intermediary agent between seller firms and the headquarter office. Its functions are gathering information about seller firms, the hands-over documents relevant to transactions, and so on. The Fig. 3 depicts the AS-IS model for the current process.

TO-BE model construction

Developing a TO-BE model from an AS-IS model is not an easy task since it requires lots of experiences and expertise of reengineering. The basic idea of this methodology is benchmarking the redesign experiences of past BPR projects, i. e., the transformational knowledge. When the most relevant BPR case is selected, this BPR case acts as a starting point for an alternative TO-BE process generation and suggests building block activities to the current BPR project. Fig. 4 depicts a heuristic procedure of the TO-BE model construction process.

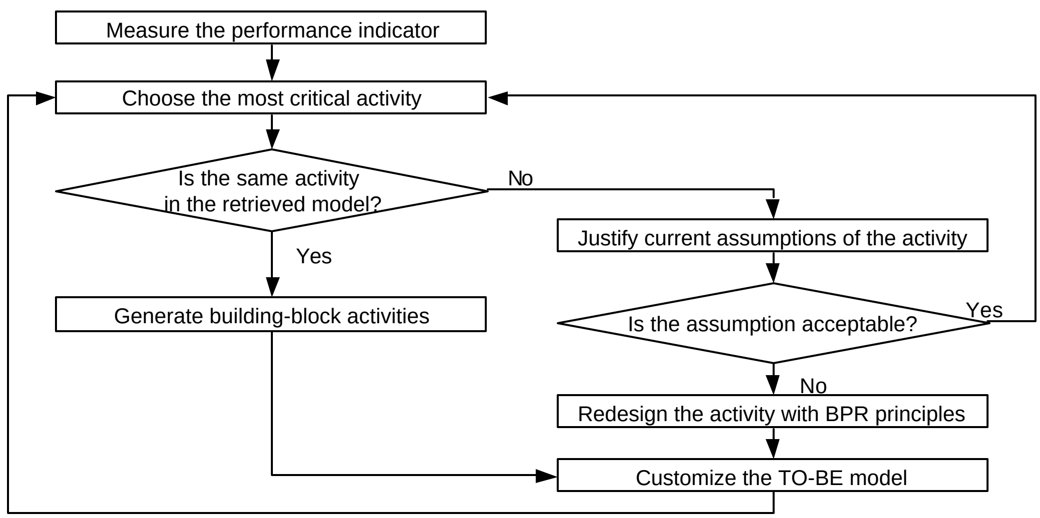

Figure 4. A heuristic procedure of the TO-BE model construction

The major problems identified by the managers of ABC Ltd. about the performance of AS-IS business processes can be summarized as follows:

1. Duplication of work. The most important task in import process is collecting the information about "who need what products provided by which suppliers." Employees in both headquarters and overseas branches gather similar information through different channels. Sometimes the information reported by the two parts does not match. It raises problems about misunderstanding the counterpart firms.
2. Excessive communication time. It spends much time on handing over the various documents required for the transaction between headquarters and seller firms. The time it takes for the agreements to be contracted is unnecessarily long, sometimes resulting in an unsettled negotiation.

In our example, BPR team used the activities' cycle time as a performance indicator. A PROCESS activity 'collect seller information' takes long cycle time since the information exchange about the merchandise between the overseas branch and sellers are frequently occurred. And it is duplicated in both headquarters and overseas branches.

CAPS compared an AS-IS model of the current process to that of the retrieved case. But, the retrieved AS-IS model do not have the same activity to a PROCESS activity. Because long cycle time of PROCESS activity 'collect seller information' and duplication of the same work in both headquarters and overseas branches is not acceptable to BPR team. CAPS suggested that a PROCESS activity 'collect seller information' is transformed into an EVENT activity 'search information' by deploying the transformational knowledge associated with that activity from the BPR principles. Also, the information technology (i.e., a shared database having the relevant information) is deployed in the retrieved case since it reduces the cycle time in collecting relevant information Fig. 5 shows transformational knowledge as an illustrated example.

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{{ Transformational knowledge -Collect information
    As-Is activity : PROCESS(Collect information)
    To-Be activity : EVENT(Search information)
    New station : Purchasing department
    Changed processing-time : (5 days, 1 hour)
    Deployed technology: shared database
    Purpose of change: reduce cycle time in collecing information
}}
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Figure 5. An example of transformational knowledge

A STATION 'overseas branch' has many functions such as collecting the diverse information about markets, products, and related firms, communicating with foreign firms, and coordinating the trading transactions. Because of the advancement of telecommunication technology such as e-mail, EDI, and the Internet, the headquarters is able to communicate directly with the foreign firms in developed countries. ABC Ltd. is able to reduce the human resources in overseas branches and change the their work-roles from the administration work of making documents to developing new markets or firms. Fig. 6 shows an alternative TO-BE model of the current process.

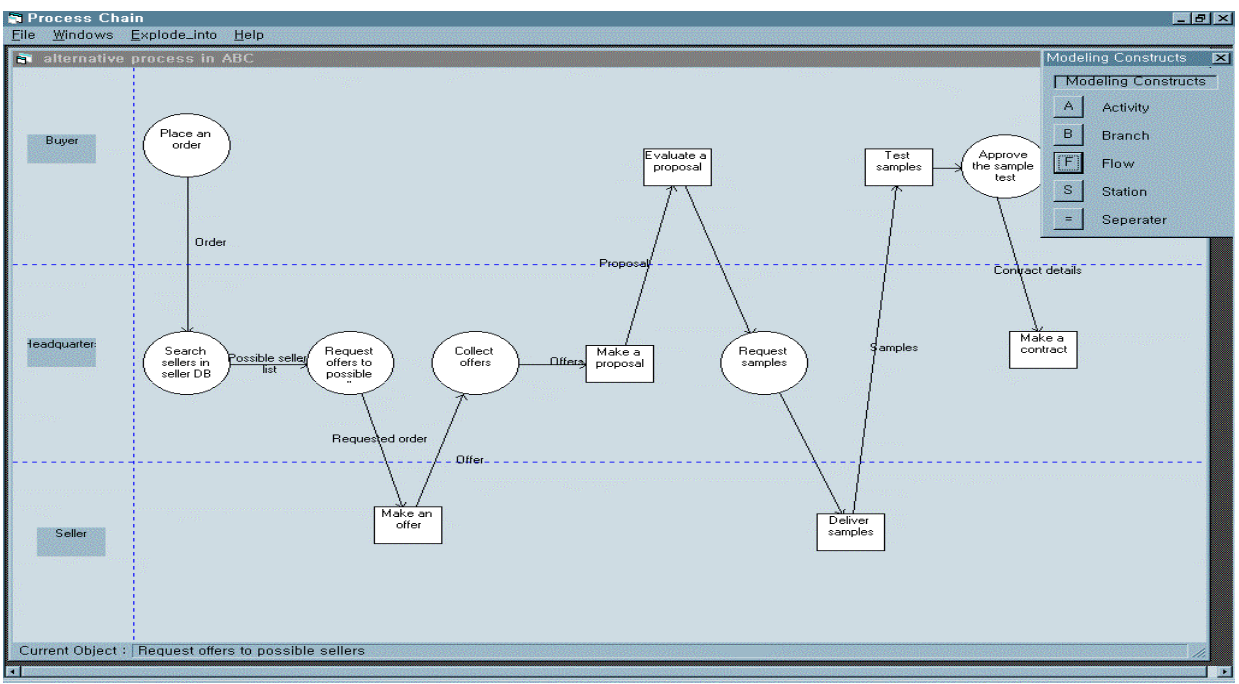

Figure 6. An alternative TO-BE model of the current process

5. Conclusions

In this paper, we described a knowledge-based support system, CAPS for enhancing process modeling in using a case-based reasoning methodology with building-block approach. We applied CAPS to the trading company case, and explained step by step. CAPS enables the BPR team to effectively exploit the information from past cases, namely a set of process models and its transformational knowledge produced in past cases of BPR projects. Through the building-block approach, we focused on business activities, which, when grouped together, form business processes. The heuristic procedure proposed in this paper enables us to develop new alternative process models by associating the retrieved building-block activities with those we had. This means that the methodology proposed in this paper can enlarge the solution space available for the new BPR project and make the alternative process more creative and coordinated. Consequently, it enables us to perform the BPR project with less risk and high possibility for success.

However, it has a few limitations yet to be solved. First, in the retrieval process, any other measures, such as the weighted sum, will be more helpful than our simple scoring method. Second, it is necessary to gather lots of real BPR cases in order to be a powerful application system. Recently, the environment of a trading company is changing explosively into the Internet-based transaction. It is growing the demand to consider such a new environment of the business-to-business electronic commerce. We believe that this study encourages researchers to develop new techniques and software to support other approaches.

REFERENCES

Curtis, B., Kellner, M. I., & Over, J. (1992). Process modeling. *Communications of ACM*, 35(9), 75-90.

Davenport, T. H. (1993). *Process Innovation: Reengineering Work through Information Technology*, Harvard Business School Press.

Hammer, M., & Champy, J. (1993). *Reengineering the Corporation*, Harper Business.

Kim, H. W., & Kim, Y. G. (1997). Dynamic process modeling for BPR: A computerized simulation approach. *Information and Management*, 32(1), 1-13.

Kim, K. -H., & Kim, Y. -G. (1998). Process reverse engineering for BPR: A form-based approach. *Information and Management*, 33(4), 187-200.

Kim, S. I., Kim, J. K., & Kim, S. H. (1999). A Case-Based Support for the Process Modeling in BPR. In *Proceedings of 5th Pacific Asian Conference on Expert Systems*, Feb.11-12, Los Angeles, USA.

Kim, S. I., Kim, J. K., & Kim, S. H. (2000). A Case-Based Reasoning Approach to the Development of Process Models in BPR. *International Journal of Information Management*, Forthcoming.

Kim, Y. G. (1995). Process modeling for BPR: Event-process chain approach. In *Proceedings of International Conference on Information Systems*, 109-121.

Ku, S., Suh, Y. H., & Tecuci, G. (1996). Building an intelligent business process reengineering system: A case-based approach. *International Journal of Intelligent Systems in Accounting, Finance, and Management*, 5(1), 25-39.

Maher, M. L., & Zhang, D. M. (1993). CADSYN: A case-based design process model. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, 7(2), 97-110.

Martinsons, M.G. (1995). Radical process innovation using information technology: The theory, the practice and the future of reengineering. *International Journal of Information Management*, 15(4), 253-269.

Pearce, M., Goel, A. K., Kolodner, J. L., Zimring, C., Sentosa, L., & Billington, R. (1992). Case-based design support: A case study in architectural design. *IEEE Expert*, 7(5), 14-20.