"Issues in designing a Knowledge-based system to support process modeling"

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ABSTRACT

Information systems development entails planning, analysis, design and construction phases. The analysis phase identifying user requirements is the most important of these phases. Since unidentified defects in the early phase causes increased work and costs as development proceeds, the quality of analysis results affects the quality of the resultant system. Major tasks in the analysis phase are data modeling and process modeling. Research on building a knowledge-based system for data modeling have been conducted much, however, not sufficiently for process modeling. As a system environment with high user interaction increases, research on process modeling methods and knowledge-based systems considering such environment are required.

In this research, a process modeling framework for information systems with high user interaction is suggested and a knowledge-based system for supporting the suggested framework is implemented. A proposed model consists of the following tasks: event analysis, process analysis, and event/process interaction analysis. Event analysis identifies business events and their responses. Process analysis break down the processes of an enterprise into progressively increasing details. Decomposition begins at the function level and ends when the elementary process level is reached. Event/process interaction analysis verifies the results of process analysis and event analysis. A knowledge-based system for supporting a proposed process modeling framework is implemented in a web-based environment.

Keywords: Knowledge-Based System, Process Modeling, KBSPRM, Event Analysis, Process Analysis, Interaction Analysis

1. INTRODUCTION

The development life cycle of an information system is generally composed of planning, analysis, design, and construction. The planning phase, related to business goals, strategies, and critical success factors(CSFs), determines how to use information technology to spawn new business opportunities and achieve a competitive advantage. Business functions, data and information needs at higher level are extracted.

The analysis phase includes answers to the following questions: which process is needed, how to interact with other processes, what kinds of data are needed and what are the relationships among these data. A data model and a process model are produced in the analysis phase. The design phase is related to how processes are implemented to procedures and how procedures operate. A data model is converted into a data structure for a target system environment. Active user participation is required during this phase. Procedures are implemented using a code generator or a development tool in the construction phase [5].

Since all business requirements are extracted and specifications of information system development are completed in the analysis phase, it is the most important phase among all phases. Since unidentified defects in the early phase create additional work and costs as development proceeds, the quality of analysis results affects the quality of the resulting system.

The analysis phase consists of the following tasks: preliminary analysis, data modeling, process modeling, interaction modeling, current system analysis, distribution analysis, and business model confirmation [3]. Data modeling and process modeling are the core tasks of the analysis phase. Because data modeling and process modeling depend on experience and knowledge of modeling experts, a knowledge-based system based on experience and know-how of experts can be helpful in the analysis phase. In data modeling, there have been several knowledge-based systems in the literature [4,7]. Yet, there have been few attempts to build a knowledge-based system for process modeling [1,2,4]. As system environments with high user interaction increases, research on process modeling considering such environment and knowledge-

based systems are required.

In this study, a process modeling framework for systems with high user interaction is suggested and a knowledge-based system for supporting the suggested framework and assuring the quality of analysis results.

2. A PROPOSED PROCESS MODELING FRAMEWORK

Success in system development highly depends on quality of analysis. Therefore, existing modeling techniques must be continuously improved in order to conceptualize real business needs completely, rapidly, and without redundancy. Such improvement is essential to process modeling. Although existing methodologies instruct to perform data analysis and process analysis in parallel, techniques of data modeling have been more widely studied than that of process modeling.

Recently, user interaction with information systems has gradually increased. For example, most web sites provide not only electronic commerce functionalities such as shopping mall and internet banking, but various forms of user involvement such as online consultation, discussion rooms, and user communities. Although systems are not web-based, the number of business operations interacting with users frequently is increasing. For example, most processes of financial facilities are invoked by customer requests. Under such a system environment, process modeling should be performed considering user interaction sufficiently. External events triggered by users should be analyzed enough. Event analysis identifies external stimuli at first and focuses on tasks performed by employees.

Benefits of event analysis are as follows. First, user involvement can be improved. Second, it prevents bias due to existing processes and an organizational structure. Third, it helps to verify correctness and completeness of a process model. Lastly, reusability of processes can be enhanced by finding sharable processes among event responses.

This study proposes an event-based process modeling framework considering system environment with high user interaction. Task diagram of a proposed framework is shown in figure 1.

Guidelines and rules for each task were extracted through interview with modeling experts and evaluated by developers in a large-scale project.

Event analysis

Event analysis is based on the fact that all business activities have pre-defined responses according to an expected situation. Event analysis can be a complementary concept to process modeling since it identifies events and their related responses independently of modeling. Event analysis verifies completeness and correctness of a process model in business execution perspective. To verify a process model, business processes related with each event should be defined and data dependency among processes included in event responses analyzed, and pre-conditions of each process as well. Event analysis is composed of three tasks: identify events, analyze planned response for each event, produce event lists.

Guidelines for event analysis

- All events should be related with at least one elementary process.
- All elementary processes should be included in at least one event response.

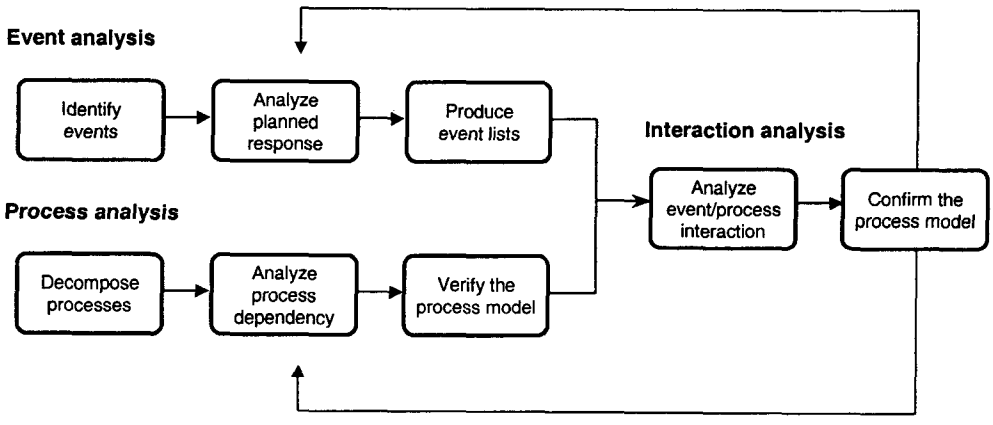

Figure 1. Task diagram for process modeling

- Elementary processes related with each event response should be placed in process hierarchy diagram.
- All external objects should be related with at least one elementary process.

Process analysis

Process analysis is used to discover what the organization needs to do in order to operate successfully. A process relates to a specific act that have definable beginning and end point. A process has identifiable inputs and outputs. Two main techniques are used in process analysis. These are process decomposition and process dependency analysis [6]. Process decomposition is the principal technique for describing the functions of a business area. Each process is broken down progressively into other processes until its component elementary processes are identified. The resulting diagram is called a process hierarchy diagram (PHD). This is the usual way to depict all processes in the enterprise. Process dependency analysis is performed after the elementary processes have been identified via process decomposition, to discover the dependencies of the processes upon each other. The output from this analysis is a process dependency diagram (PDD). Process analysis consists of the following tasks: decompose processes, analyze process dependency, verify the process model.

Guidelines for process analysis

Process decomposition

- Each process should be decomposed into two or more sub-processes.
- The number of sub-processes at any levels should not be more than seven.
- Child processes should describe their parent completely.
- Identical processes cannot exist in process hierarchy redundantly.
- Decomposition must end when the elementary process level is reached.

Process dependency analysis

- All processes should have at least one dependency.
- Sub-processes at the same level should be connected by dependencies.

Process model verification

Completeness, correctness, and consistency of the model should be verified to confirm process model.

- Completeness: Are all processes identified?
- Correctness: Is each process placed appropriately in the process hierarchy? Are any processes inadequately matched to its parent? Especially, one should be careful for processes which can be used in many business area commonly.
- Consistency: The parent activity must be completely defined by the sum of its child activities? If process B, C, and D are sub-processes of process A, then the following equation should hold. A=B+C+D. If A is greater than B+C+D, then the omitted processes should be identified. In an opposite case, one should find processes having inappropriate match.

Interaction analysis

Interaction analysis task verifies that all events and processes are identified and connected each other appropriately. In this study, interactions between events and processes have been analyzed using a matrix technique. It is not necessary to use a matrix, but a matrix technique is more easier to use than cross reference properties such as a process list by event or an event list by process. Process model reviewed and confirmed by users forms a solid basis in later development phase. This task validates all deliverables of process modeling, including event lists, event definitions, process hierarchy diagrams, process dependency diagrams, and elementary process definitions through a structured walkthrough. After problems identified during walkthrough are solved completely, a process model is finally confirmed.

Checklist for interaction analysis

- Are there any events having no related processes?
- For each event, are related processes too many or few?
- Are there any processes having no related events?
- For each process, are some related events too many?

3. IMPLEMENTATION

KBSPRM(Knowledge-Based System for Process Modeling) supporting process modeling approach proposed in this study is implemented. System design and data collection are performed through interviews with modeling experts. KBSPRM conforms to a generic architecture of a knowledge-based system. Database and knowledge base are implemented using Microsoft SQL-Server and a user interface is implemented under web-based

environment. An overall architecture of KBSPRM is shown in figure 2.

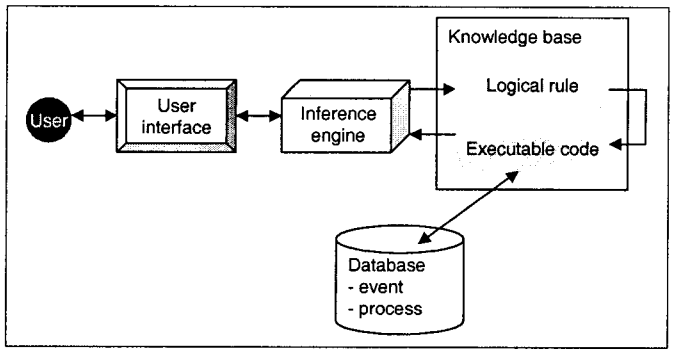

Figure 2. An overall architecture of KBSPRM

KBSPRM is composed of database, knowledge base, inference engine, and user interface. Database stores all data produced during modeling procedures and knowledge base stores rules enforcing modeling guidelines and conventions. Knowledge base can be classified into logical rule base and executable rule base. Inference engine finds an appropriate rule when a certain situation occurs. Next, the rule calls an executable code and the program is executed. User interface displays diagrams using input data by users and produces consistency check report.

Main functionalities of KBSPRM

A main menu of KBSPRM consists of planning, analysis, design, and construction. Analysis module provides data modeling, process modeling, and data/process interaction modeling menu. A process modeling task is composed of event analysis, process analysis, and event/process interaction analysis. Scope of implementation in this study is limited to the process modeling function.

- Event analysis: Event definition, event response list, consistency check menu are provided. Once users define events, KBSPRM displays all input events in list form.
- Process analysis: This module is composed of process definition, process hierarchy diagram, process dependency diagram, detailed profile including linkage to related events, consistency check menu. When users define processes by level, system generate and display process hierarchy diagram based on input data. Figure 3 is a screenshot of process hierarchy diagram of KBSPRM

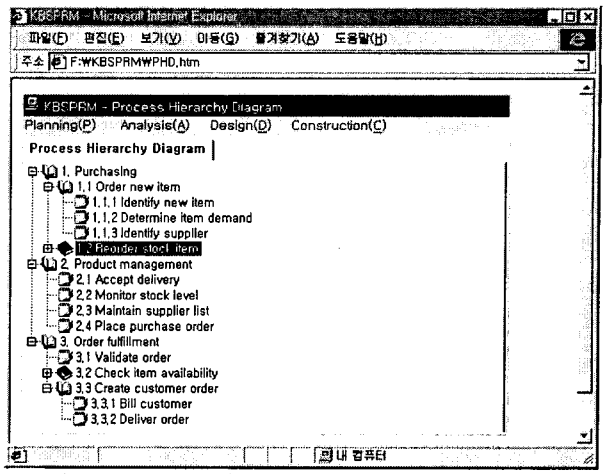

Figure 3. Process hierarchy diagram (KBSPRM)

- Event/process interaction analysis: Event/process involvement matrix is provided for interaction analysis. A row of matrix means events, and a column means processes. 'X' in cell which cross a specific row and a specific column means that the process is used in the event response. All events and processes should be verified for populated cell values. Figure 4 is a snapshot of the event/process matrix.

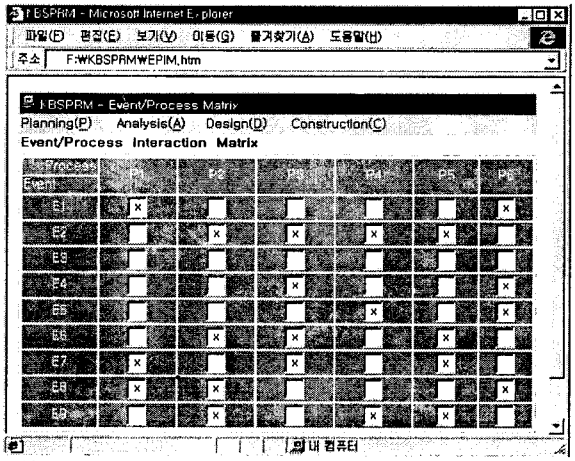

Figure 4. Event/process interaction matrix (KBSPRM)

KBSPRM provides a number of verification rules concerning each modeling task such as event analysis, process analysis, and interaction analysis. All rules are stored in a knowledge base and when system users call a certain action, inference engine of KBSPRM invokes an appropriate rule and executes. The following statements specify parts of matrix verification rules.

IF matrix_check is triggered
while event is not empty {

```
IF for an event, related_process is null
THEN store event name to list_of_temp_E231
/* E231 = 'Error: related process(es) not exist' */
ELSEIF for an event, related-process < 2
THEN store event name to list_of_temp_W231
/* W231 = 'Warning: the number of related process(es) less than 2'
*/
ELSEIF for an event, related-process >= 10
THEN store event name to list_of_temp_W232
/* W232 = 'Warning: the number of related process(es) not less than
10' */ };
```

These are converted to executable source code and then stored in the knowledge base. When a user chooses 'check' in the menu, an inference engine extracts an appropriate rule and executes the program. As a result, a consistency check report is generated which can improve the quality of the analysis results by providing analysts and users with a chance to confirm the model.

4. CONCLUSION and ISSUES

Modeling activities in the system development life cycle are knowledge and experience intensive tasks in that their quality is highly affected by experience and the know-how of the analyst. Therefore, building and utilizing a knowledge-based system based on knowledge and experience of the modeling expert concerning modeling procedures and conventions may improve the quality of the resultant system.

In this research, procedures in building a knowledge-based system for process modeling are examined. A process modeling approach focused on system environment with high user interaction is proposed. An event-based process modeling approach is suggested reflecting the fact that most businesses are initiated by an external event. The proposed method is composed of an event analysis, process analysis, and event/process interaction analysis.

An event analysis produces event response lists; Next, process analysis makes out process hierarchy diagrams and process dependency diagrams. Interaction analysis employs a matrix technique to provide an intuitive interface to users. A knowledge-based system(KBSPRM) under web-based system environment is implemented for supporting the proposed method in this study. KBSPRM consists of a database, a knowledge base, an inference engine, and a user interface. A knowledge base includes logical rules and executable code. When a pre-defined situation occurs, a proper rule is invoked and executable code is called by inference engine.

Future research includes developing a knowledge-based system for supporting whole activities in the analysis phase. Knowledge-based system for data modeling having consistency with KBSPRM needs to be developed, and then two systems require to be integrated. Integrated system should also provide cross check techniques between a data model and a process model.

5. REFERENCES

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