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Using Rule Technology for Fraud Prevention in Government Insurance

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Abstract. In respect of the frequent fraud cases of social insurance by government organizations, the inspection procedure usually relies on experts' experience for verification and experienced personnel in charge for checking. However, due to the heavy work load and the insufficiency of manpower and lack of experience, the ratio of miscarriages of justice is very high, leading to improper settlement of claims and the waste of social resources. In this paper, we employ rule technology to improve the above inefficiency. We employ a knowledge engineering methodology to analyze the problem and construct the knowledge model, including the domain schema and rules. We then implement the knowledge model along with the existing database applications. The benefits generated by the research are: (1) establishing a knowledge system with expertise reasoning to solve the review problems of massive cases, (2) significantly reducing the large labor cost and consumed time of the existing reviewing system, and (3) improving the application level of traditional database in the expert reasoning system.

Keywords: Knowledge engineering, Domain Schema, Rule, Government insurance

1 Introduction

The scope of public insurance comprises five categories: physical injury, handicap, maternity, death and aging [1,2]. The application of insurance claims comprise two categories: one is common injury insurance and the other is occupational hazard insurance. In this paper we focus on conducting against common injury insurance claim. The existing problems are as follows:

- The time required for review is 45 days; if the case is judged to be dubious case, then the corresponding court administration department will be notified for assistant investigation, which will last for almost 30 days for confirming whether the case belongs to fraud case; the overall process requires about 75 days, the consumed labor and time are enormous.
- The endless emerging of false claim cases related to insurance fraud requires the reinforcement of check and screening of fraud cases. Due to the massive operation volume and restricted by limited human resources and inadequate experience, it is not practical to carefully screen the cases one by one.
- Due to the enormity of cases require for recheck, only 20% cases sampled for mining and the accuracy rate is only 15%. In addition, during the judgment at each operation phase (acceptance, check and payment checking), the experience is not easy to be shared and even through educational training, there is still no evident effects. Obviously, the exiting operation can not adequately solve the above-mentioned problems.

Directing towards the solution of the forementioned problems, the following requirements must be satisfied for various roles in the context.

- **Business staff**: Be capable of obtaining each piece of information for case review, including the representative and expert domain knowledge implicit in the existing database system. A case review reasoning system is expected to assist large amount of monthly work.
- **Case applicants**: Hope to shorten the application period and rapidly obtain the review results and receive reasonable indemnity.
- **Mid-level managers**: the system can transmit and communicate the knowledge and technology related to the review, dig out the implicit expertise knowledge and design an information system which possesses case review and reasoning expertise.
- **Top managers**: The system can assist to reduce the monthly labor and time cost invested in the review, improve the accuracy, help to generalize expertise rules so as to feedback the review results to the premium rate adjustment factors.

In order to meet the above requirements, in the research, we materialize the review expertise of previous business staff using the knowledge engineering methodology CommonKADS [3]. We implement the design model using the visual rule technology, VisiRule [4]. The rule system integrates with the existing database application by using the Prolog-to-database interface, Prodata [5]. User accesses the rule system through the browser.

In the next section, we give an overview of the knowledge engineering methodology, CommonKADS. Then we describe the analysis and design of the knowledge system in Section 3. In Section 4 we describe the implementation and show the result. Finally conclusions are made.

2. Knowledge Engineering Methodology

When building a knowledge-intensive system, it is appropriate to adopt a comprehensive methodology, because the ‘knowledge’ can not be obtained just by

someone's intuition or conjecture. The adopted methodology should facilitate the detailed analysis and complete treatment of knowledge-intensive tasks and processes. CommonKADS methodology is excellent for the above purpose. The CommonKADS methodology offers a structured approach based on a few basic thoughts or principles which have grown out of experience over the years. The total process of CommonKADS actually is developing the six predefined models with each of them focuses on one limited aspect and the combination is a comprehensive view of the whole system. The six models are organized into three levels, from the beginning of contextual consideration (organization, task and agent models), to the conceptual formation (knowledge and communication models), and then to the generation of design artifacts (design model). Each individual aspect of the models is explained as follows.

- *Organization model:* helps analyze the rough feature of the system and find out the problems and opportunities.
- *Task model:* The business process can be divided into several sub-processes, which are the tasks. The task model analyzes the global task layout, the inputs and outputs, the preconditions, and the performance criteria.
- *Agent model:* Descript the capabilities, authority and constraints of the agents, which are the executors of a task.
- *Knowledge model:* The knowledge model specifies the essential knowledge when executing a task.
- *Communication model:* When it comes to multi-agent environment, the communication model conceptually expresses the transactions of agents which involved in a task.
- *Design model:* proposes a technical system specification including architecture, implementation platform, software modules, representational constructs, and computational mechanisms based on the integration of the requirements.

3. Analysis and Design

We first describe the business flow of public insurance claim. Then we show the result of problem analysis and design model using CommonKADS.

3.1 Analysis of Public Insurance Claims

The business flow of governmental insurance claim is shown in Fig. 1. After accident occurs to the insurer and the insurer is sent to hospital for treatment, the unit where the insurer belongs to fills in an application sheet and ensures that the related documentary evidence is sent to the insurance unit; after the documentary evidence is received, the information is entered via the dedicated insurance application system and then it is decided whether the payment will be checked after the audit mechanism

conducts review for the content and the related case history and then the claims settlement can be conducted.

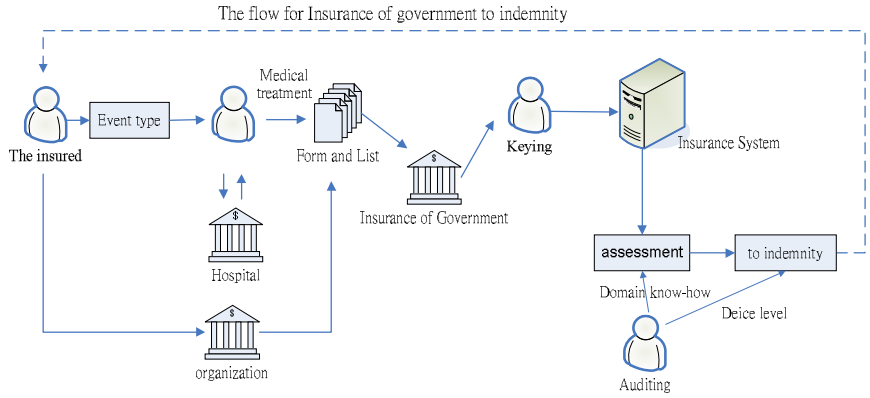

Fig. 1. Business flow of governmental insurance claim

3.2 Contextual Analysis

As mentioned in Section 2, the CommonKADS starts from the contextual analysis which results in three models, that is, Organization, Task and Agent Models. Firstly, in the analysis of Organization Model, the analysis to the problems and opportunities is required and at the same time, the task and mission of the organization shall be clarified.

At present, many cases which apply for claim settlement require to be reviewed and great challenge is made to manual review, which is the biggest problem. In addition, at present, there is no integrated information system to provide cross query. Expert judgment is required when the cases are reviewed, the related knowledge is not easy to be transmitted and communicated. Therefore, it is usually the case only after the payment is made, the case is found to be a fraud. Both difficult recovery of the payment and the lengthy procedure constitutes existing major problems. The mission of the case is to find out the problem case in the most effective and time-saving way and to establish a more convenient reasoning knowledge system. At the same time, the strategy for reaching the goal and expectation is to extract the core knowledge of profession reviewers via expert interview.

The study analyzes the related organization according to the work flow surface as the following figure and define the department which can provide various human resources; in the public insurance organization, the insurance claim team is responsible for the review of claim application cases, which is subordinate to the insurance department; subordinately provided with professional reviewers for case review as well as payment checking staff for calculation of claim amount; meanwhile, there is also dedicated service counter that is responsible for receiving the applications and providing information system to assist the reviewers for assessment. The organizational chart is as shown in Fig. 2.

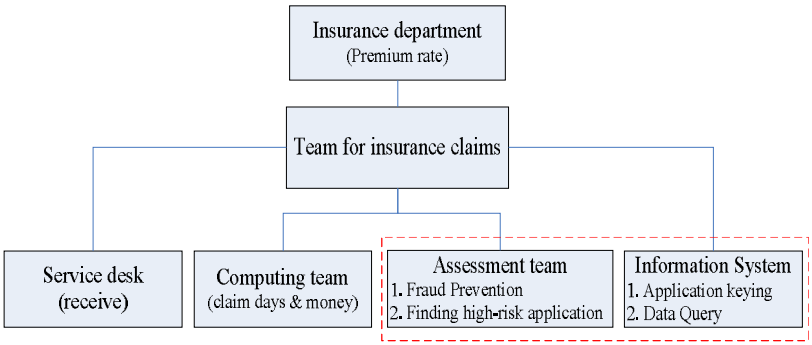

Fig. 2. Analysis of Related Organization

The primary process, as shown in Fig. 3, comprises a number of tasks, among which List item check, Query for IS (information system), Assessment, and Re-Assessment (table 1) are knowledge intensive tasks. The tasks are further decomposed with dataflow and control flow diagrams shown in Figs. 4 and 5, respectively.

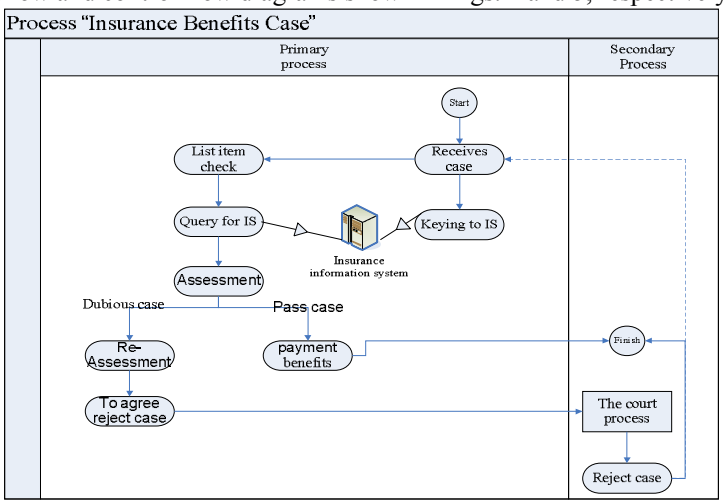

Fig. 3. Process analysis

Table 1. Key knowledge assets analysis

Task	Performed by	Where	Knowledge asset(s)	KI?	Sig.
List item check	Insurance room Worker	Manpower	Check data and laws	KI	1
Query for IS	Insurance room Worker	Manpower use IT system	Search way	KI	1
Assessment	Audit Worker	Manpower	To separate dubious and pass from case	KI	1
Re-assessment	Audit Worker	Manpower	To separate dubious and pass from case	KI	1

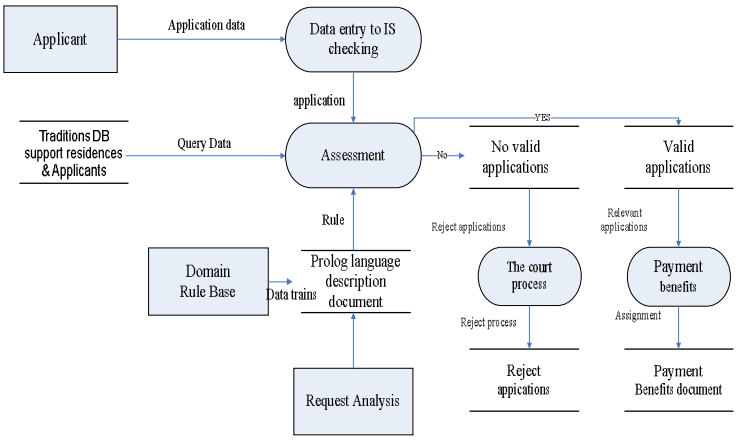

Fig. 4. Dataflow of the tasks in the primary process

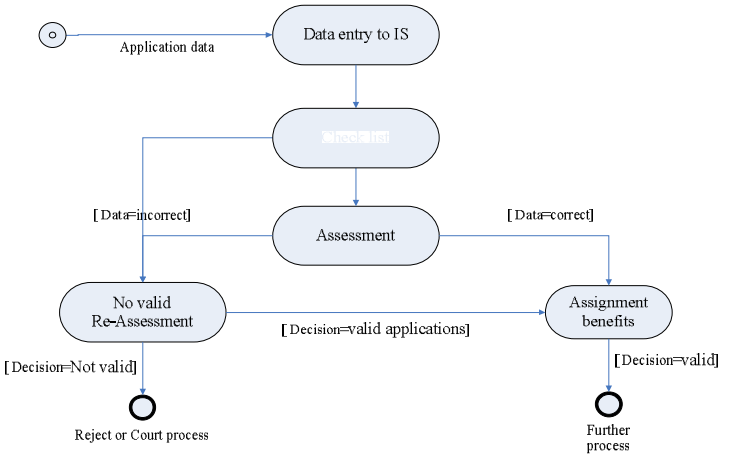

Fig. 5. Control flow of the tasks in the primary process

Through the interview with auditing experts and the classification of existing rules and regulations, we summarize the following knowledge items used to in the assessment task.

Rule 1：*Inspection already adjustment in hospital number of days*

(If in the application case above insured's historical accumulation in hospital's number over 180 days, already surpassed the legal adjustment in hospital days number upper limit, then must reject application, and need to manual inspection).

Rule 2：*Inspects the insured to be effective*

(If record of date and the insured the application case reject insurance from the insurance date to surpass for 30 days, then must reject application, and need to manual inspection).

Rule 3: Check insured's data by changed

(If in 30 days insured's basic data or the beneficiaries have the change record, then draws back to carry on the manual inspection).

Rule 4：Inspects insured's organization

(If insured's organization is an association, then regards as the high risk application case, after must reject application, and need to manual inspection).

Rule 5：Insurance salary unreasonable change

(If the insured wish obtains a higher indemnity, is bigger than 30% in 1 year individual salary (column in database) promotion, then regard it as the high risk case and need manual assessment).

Rule 6：Inspection accumulation insurance period of service

(If the insured joins the government social security record accumulation to be short in 12 months, than must reject application, and need to manual inspection).

Rule 7：Inspects hospital reliability

(If hospital of the application case once the proof not truly condition or is had the bad row tube record, than must reject application, and need to manual inspection).

Rule 8: Inspects doctor reliability

(If of doctor in charge application case once the proof not truly condition or is had the bad medical record, than must reject application, and need to manual inspection).

3.3 Conceptual Analysis

This level of analysis is to derive the knowledge model and communication model based on the analysis result of the contextual analysis. The former is used to design the knowledge based and the latter describes the communication paths among agents and sub-systems.

The assessment and re-assessment tasks in the contextual analysis are categorized as assessment type in the task hierarchy [3]. In this paper, we therefore adopt the inference structure, control structure and domain schema of the assessment task as the basis to carry out the analysis and then build the knowledge model. In this section we focus on the development of the main rule model of the "review knowledge system for insurance claim cases with reasoning capability" and it is designed based on the knowledge items from the previous contextual analysis. Therefore, the important core domain projects sorted out according to the above-mentioned rules comprise the following important project rules: (1) Auditing the cases of payment days (2) Auditing the validity period of insurance (3) The review data stability (4) Audit of the insured's organization (5) Reliability insured's salary review (6) Check to years of cumulative insurance (7) Check to high-risk hospital (8) Check to high-risk doctor. The knowledge model is drawn as shown in Fig. 6.

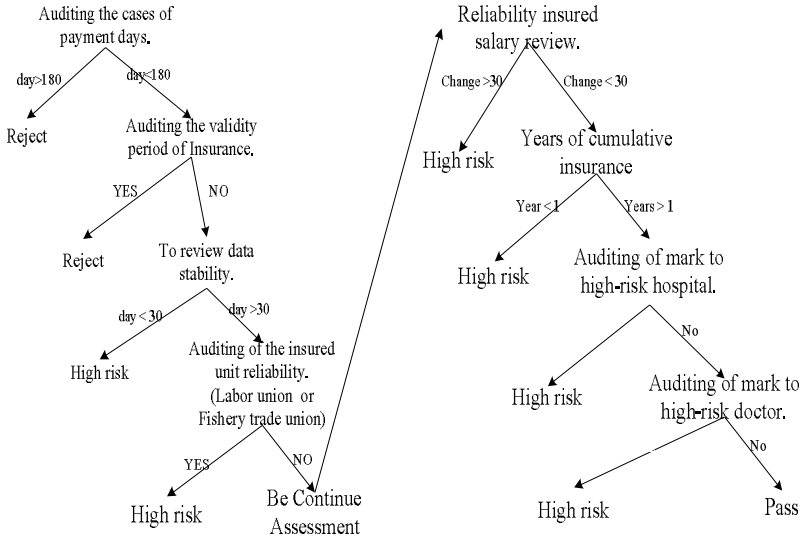

Fig. 6. Review knowledge model for public insurance claim cases

4. Implementation

In this section we describe the implementation of the knowledge model using the visual rule technology, VisiRule [4]. The system architecture is outlined as shown in Fig. 7.

The right-hand side in the figure is the current system architecture. In the left-hand side is the enhanced part using rule technology. The auditing personnel access the knowledge based system through the service interface; the knowledge base administrator uses the management interface, here, the VisiRule as shown in Fig. 8. For example, to maintain the knowledge base:

The resulting code after using the visual interface can be Flex [6] or Prolog [7], which is automatically generated, compiled and ready to run. In the resulting Prolog program, we use the Prolog-to-Database interface, Prodata [5], to integrate with the existing database applications.

We have implemented a prototype of the knowledge-based system in Fig.8 using VisiRule. At present, we implement the knowledge model described in Section 3 in the prototype. Input single id for Rule System to check in Fig. 9, used the batch job to demo rule system shown in Fig. 10.

To see how the prototype performs, we carried out an experiment based on the history data with the result summarized in Table 2.

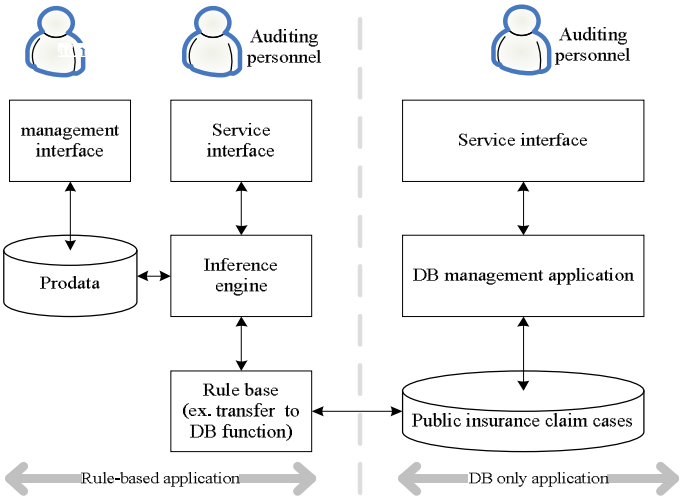

Fig. 7. System architecture enhanced by using rule technology

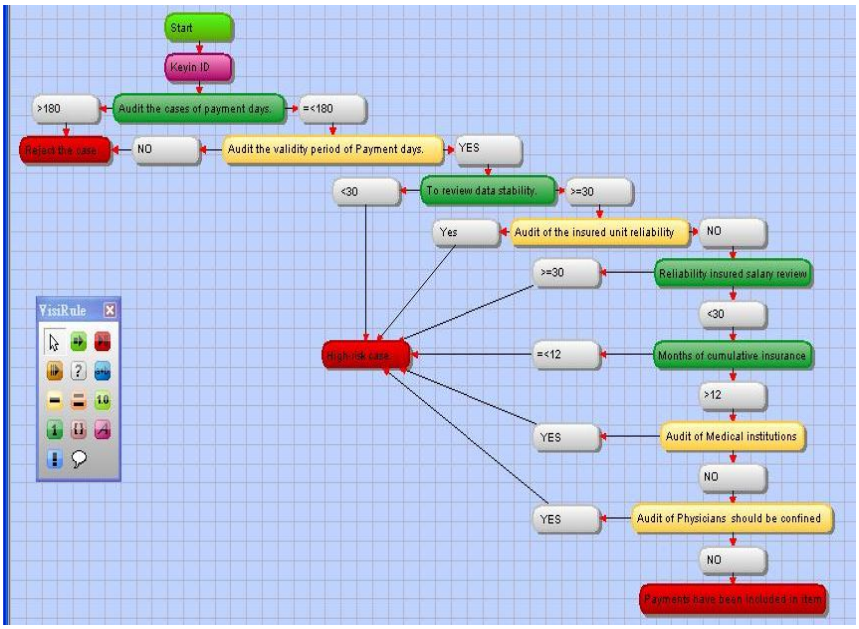

Fig. 8. User interface for managing rule base

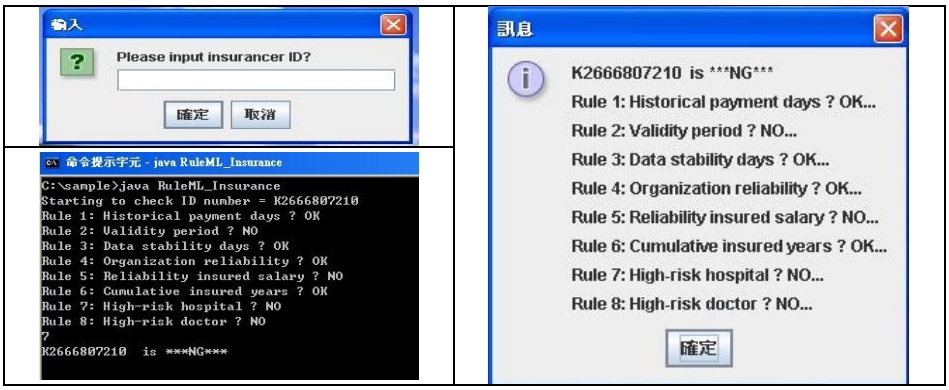

Fig. 9. Input single id to rule system process

Fig. 10. Batch job to rule system process

Table 2. Performance evaluation of the prototype system

	Current System	**Enhanced System**
Processing time	22 day/ month	10 day/month
Assessment rate	Cover 20% of the cases	Process 100% of the cases
Precision of assessment	30%	79%
Personnel required	Data inquiry 16 (man-month) Expert 8 (man-month) Reassessment 4 (man-month)	Data inquiry 4 (man-month) Expert 2 (man-month) Reassess 2 (man-month)
Loss of money	US$1,584,098 (per year)	NT$353,894 (per year)

- **Note 1**: There are about 170.000 application cases each month. Due to the great number of the cases, it takes 22 days to manually process 20% of the cases each month. Using the knowledge-based system, it only needs 2 to 3 days to process all the cases.
- **Note 2**: According to the historical information, there are in average 600 fraud cases of insurance claim, creating loss of roughly US$1,584,098 every year. based on manual assessment, only 6% of the 600 cases are discovered, resulting loss of NT$51,800,00. Using the knowledge-based system, the assessment rate is 100% among which 21% can not be sieved due to regulation flaws, incomplete input document, bad procedure and unknown factors. Thus it is improved from 6% to 79% of the fraud cases that can be discovered; the loss of money is reduced to be NT$353,894.

5. Conclusions and Future Work

In this paper, the core knowledge for public insurance review can be effectively established via knowledge engineering methodology, CommonKADS. The visual rule technology, VisiRule, is used to implement the knowledge model derived from the analysis and design using CommonKADS methodology. We carried out experiments using the prototype system. The result shows that originally using the manual assessment only 6% of the fraud cases are discovered. With the use of rule technology, 79% of the fraud cases can be discovered which results in save of lots of money. The experiment result shows that the use of rule technology is promising in improving the performance of heterogeneous databases.

In this paper we obtain preliminary success of using the rule technology to build up the knowledge-based system. In the future, we will combine the knowledge model developed in this paper with the result using data mining technology to extend the coverage of the knowledge base [8]. At present, various database systems are used in the application of managing governmental insurance. In this paper we rely on manual access of various databases to collect the items to be checked by the rule-based system. The Semantic Web technology is suitable for integrating databases of various formats [9]. We will employ this technology to automate the task of collecting data from various databases.

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