Development of the Knowledge-based Systems for Anti-money Laundering in the Korea Financial Intelligence Unit

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This case study shows constructing the knowledge-based system using a rule-based approach for detecting illegal transactions regarding money laundering in the Korea Financial Intelligence Unit (KoFIU). To better manage the explosive increment of low risk suspicious transactions reporting from financial institutions, the adoption of a knowledge-based system in the KoFIU is essential. Also since different types of information from various organizations are converged into the KoFIU, constructing a knowledge-based system for practical use and data management regarding money laundering is definitely required.

The success of the financial information system largely depends on how well we can build the knowledge-base for the context. Therefore we designed and constructed the knowledge-based system for anti-money laundering by committing domain experts of each specific financial industry co-worked with a knowledge engineer.

The outcome of the knowledge base implementation, measured by the empirical ratio of Suspicious Transaction Reports (STRs) reported to law enforcements, shows that the knowledge-based system is filtering STRs in the primary analysis step efficiently, and so has made great contribution to improve efficiency and effectiveness of the analysis process. It can be said that establishing the foundation of the knowledge base under the entire framework of the knowledge-based system for consideration of knowledge creation and management is indeed valuable.

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1. Introduction

Since the 9.11 attacks in 2001, there has been significant increase in number of regulations against money laundering and terrorist financing. These were initiated by the UN and Financial Action Task Force (FATF) on money laundering to encourage other countries to adopt an anti-money laundering (AML) system.

In recent times, the requirements and standards for these regulations have become increasingly stringent.

To actively join the global anti-money laundering effort and construct a transparent financial system in the domestic economy, the Korea Financial Intelligence Unit (KoFIU), a specialized national agency responsible for receiving, analyzing and disseminating information on suspicious transactions, was established in 2001. The main role of the KoFIU is to filter and provide information on suspicious transactions that require investigation from the Prosecutor's Office, National Police Agency, National Tax Service, Korea Customs Service, Financial Supervisory Commission and National Election Commission. Therefore, to better detect illegal transactions regarding money laundering reported from financial institutions, the adoption of a knowledge-based system in the KoFIU is indispensable.

The definition of money laundering varies depending on the objective of each organization, but the general definition by FATF, an affiliated organization of the OECD, is "the process of criminal proceeds in order to disguise illegal origin." Under the objective of this case study, which is the adoption of the knowledge-based system into the KoFIU, the definition of money laundering is the acquisition or disposition of illegal asset, application of income derived from criminal activities, and the subsequent disguising of the source of that income to make it appear legitimate as stipulated in Korea's Anti-Money Laundering Act. In addition, money laundering encompasses activities such as deceiving the authorities by making assets appear to have been obtained through legal means with legally-earned income or to be owned by third parties who have no relationship to the true owner (Chang, 2005). The distinct characteristic of the definition used in this case study is that concealing of asset using foreign exchange is included. This requires the AML system in the KoFIU to address such activity as well.

According to Financial Transaction Reports Act, which is one of Korea's Anti-Money Laundering Act, the KoFIU has a suspicious transaction reporting system, a currency transaction reporting system, and Customer Due Diligence (CDD) measures for anti-money laundering. Suspicious Transaction Reports (STRs) are required to be submitted to the KoFIU when a compliance officer in a financial institute decides a transaction is suspicious and Currency Transaction Reports (CTRs) are required when the amount of cash transaction exceeds a certain amount. CDD based on Know Your Customer (KYC) policies is for the prevention of money laundering transactions though the identification of customers' personal profiles.

The KoFIU has completed a fifth phase project for the implementation of Korea Financial Intelligence System (KoFIS) to improve the effectiveness and quality of the analysis. For the purpose of heightening concern over money laundering, KoFIS was named GOOD FINDER (Good Financial Leader) in November 2006. The first phase, which started in December 2001, was completed within one year. This provided the basic foundation of GOOD FINDER for analysis of reported financial transactions. Initially, it constructed management systems

such as information infrastructure and data warehouse for storing STRs and foreign exchange transaction data. The second phase (February 2004 to October 2004) enables the process of STR receipt, information analysis and provision to law enforcements to become online. The third (June 2005 to December 2005) and fifth (2007) phase were the re-design of the knowledge-based system, embedding of extracted knowledge into the system, and improvement of GOOD FINDER, respectively. The fourth (2006) phase was constructing a portal system to interchange the status quo of reported STRs between KoFIU and a financial institute.

This case study is a summary of a part of the third and fifth phase, which is the design and implementation of the knowledge-based system based on a rules-based approach. Required knowledge was extracted by data analysis as well as committing experts of each specific financial industry such as banks, securities, insurance, and private banking.

The rest of the paper is organized as follows. The second section explains a moving trend in development of the AML system. The third section describes the background and overall structure of constructing the knowledge-based system for detecting illegal transactions associated with money laundering. The fourth section proposes the development procedure and execution of a knowledge base for the AML system. The fifth section analyzes the result of performance evaluation in a rule base of the constructed knowledge-based system. The sixth section describes monitoring and maintenance of a knowledge base. In the final section, the concluding remarks of this case study are presented.

2. A Moving Trend in Development of the AML System

The AML system should be adopted by applying various technologies under the consideration of
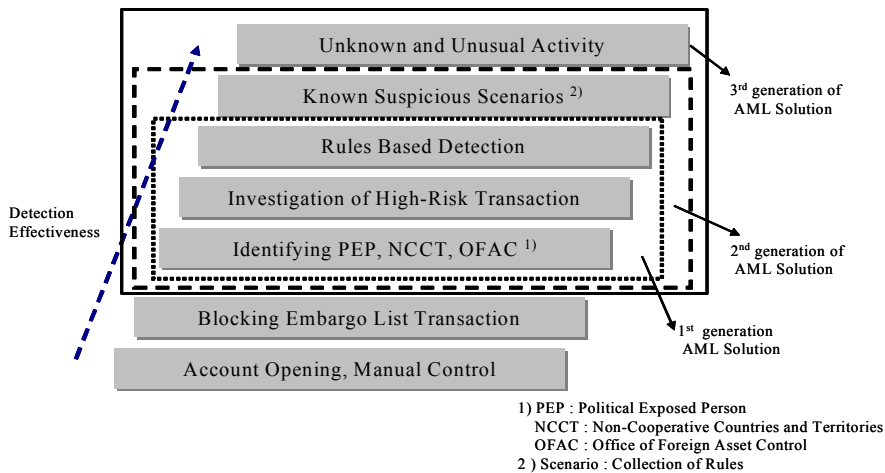
<Figure 1> A Moving Trend of the AML System

a financial environment, financial IT systems and infrastructures. In accordance with the methodology to detect suspicious transactions, the AML system is categorized as the first, second, and third generation system and the details are shown in <Figure 1> (KPMG, 2005).

In the first generation of the AML system, list filtering is used to compare the customers list in a financial unit against a terrorist and criminal list to prevent their financial activities, so the financial unit can perform self risk management. It mitigates the risky transactions of the money laundering suspect by comparing against the blacklist provided by the government or AML related organizations.

An enhanced AML system is the transaction monitoring system which does not only depend on simple query or search but also monitoring of circumstances, background or sequence of transactions. The transaction monitoring system has an advantage of automating the AML process by providing functions such as transaction data monitoring, suspicious transaction alerting, and reporting through analysis, but it will function properly only when the account and financial activity of customer is fully monitored.
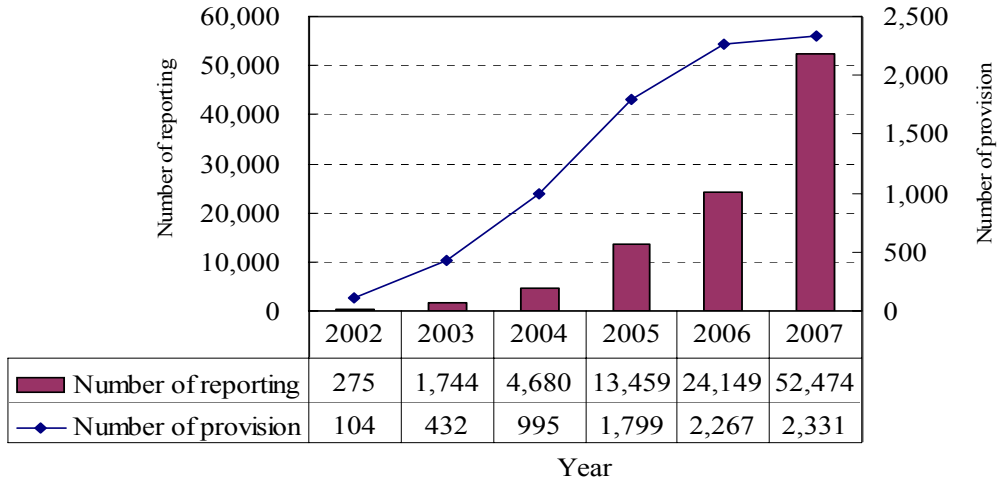
In the second generation of the AML system, the customer profile is combined with a historical transaction pattern by deriving the relationship of each other or applying a rule-based approach extracting specific transactions or activities by rules, scenarios or combination of rules. In case of using the system with this approach, a maintenance plan of the AML system such as the addition of the most current AML rules and scenario and the removal of the outdated is required through continuous monitoring.

In the third generation of the AML system, profiling methodology to detect unknown suspicious transactions by the entire or partial analysis of customer activity is adopted. Recently the methodology to score transaction, customer, and region based on primary risk factor extracted by various statistics, neural network or other Artificial Intelligence technologies is being studied much.

This methodology identifies the transaction pattern and compares it to an existing money laundering pattern to detect suspicious transaction. The third generation of the AML system has an advantage of having its risk-based objective approach based on data but it is only applicable when sufficient and representative data is acquired so it only supports selected tasks with limited resource. System adopting this methodology also requires transaction and customer information to be updated for best optimization.

3. Background and overall structure of constructing the knowledge-based system against money laundering in the KoFIU

The number of STRs reported to the KoFIU was 275 in 2002 and is expected to increase more than 190 times in 2008 as shown in <Figure 2>. Also the number of provision to law enforcements from the KoFIU is expected to increase more than 20 times as well. Since the main role of the KoFIU is to gather and analyze suspicious transactions reported by financial institutions and to provide the

| Year	2002	2003	2004	2005	2006	2007
Number of reporting	275	1,744	4,680	13,459	24,149	52,474
Number of provision	104	432	995	1,799	2,267	2,331

<Figure 2> STR Reporting Status by Year

outcome of such analyses to law enforcement agencies, the provision to law enforcements is an important activity to present the performance of those analyses in the KoFIU.

Although STRs have increased rapidly in quantitative respect, the quality of suspicious transactions reporting from financial institutions has not changed much. Consequently, the expansion of low risk transactions reporting led to lower efficiency in analysis since the resource for analyzing is limited. Just assigning more human resources to handle an increased volume of STRs is not cost efficient and may create a bottleneck in the analysis process. To better manage the exponential increase of STRs, the adoption of the knowledge-based system is essential. Since different types of information from various organizations are converged into KoFIU, constructing the knowledge-based system for practical use and data management regarding money laundering is definitely required.

To improve the efficiency of the analysis, the knowledge-based system was implemented with re-engineering of analysis process. The knowledge-based system is used 1) in primary analysis, 2) in-depth analysis in STRs and strategic analysis, and 3) target extraction for strategic analysis. The workflow of the internal KoFIU process is categorized into two tasks, STR analysis and strategic analysis by provided theme, as shown in <Figure 2>. The knowledge-based system is composed of a rule base for STR analysis and strategic analysis, and scenarios for strategic analysis. <Figure 3> shows the roles of the knowledge-based system for each analysis step of GOOD FINDER.

3.1 STR Analysis

When a STR is submitted from a financial unit or a target transaction extracted from strategic analysis is received, in primary analysis, the knowledge-based system assigns a risk rating based on the
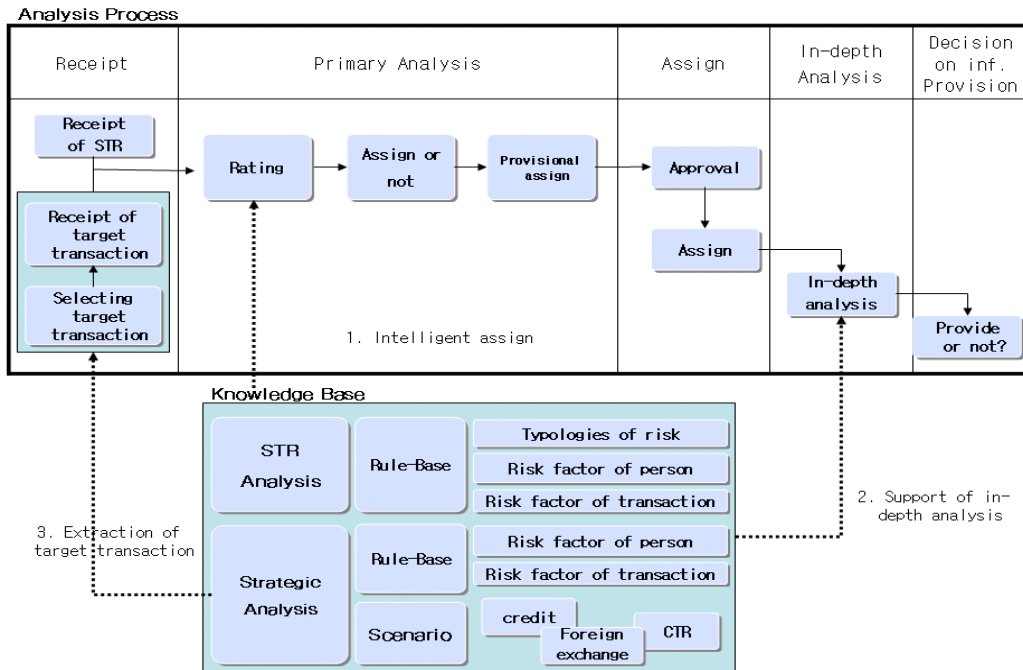
<Figure 3> The Roles of the Knowledge Base in the Architecture of GOOD FINDER

rules embedded in the knowledge base for the so-called intelligent assignment. Intelligent assignment is the risk rating-based decision making process supported by a knowledge base of GOOD FINDER, which selects a risky STR effectively for decreasing in-depth analysts' work load. In accordance with the risk rating, transaction is categorized into 3 different types : "analysis required", "analysis not required", and "uncertain." Transactions that are "analysis required" or "uncertain" are assigned to the relevant unit and analyst for in-depth analysis.

In in-depth analysis, the process of analyzing STRs in detail through gathering more information after primary analysis to provide the outcome of analyses to law enforcement agencies for investigation, the knowledge base provides analysts much information such as typologies of risk, related risk factors of persons and transactions, key points for analysis, and references to support analysis

3.2 Strategic Analysis

Strategic analysis, which analyzes various related information regarding money laundering such as foreign exchange transactions, the relationship among persons conducting financial transactions, their bank accounts, and financial institutions involved, is composed of regular analysis based on pre-defined rules and irregular analysis based on scenarios created by analysts or the combination of rules. Each rule base embarks not only a set of rules for supporting analysis task but also risk rating in-

formation and detailed information such as references or key points for analysis. Using these, the knowledge-based system provides valuable information for selecting target transactions for analysis and enhances efficiency in the analysis process. When an analyst receives a transaction for in-depth analysis, the knowledge-based system provides risk rating, key points for analysis, and references to support the analysis. After in-depth analysis, decision on whether to report this to law enforcements would be made, which is the end of process.

Furthermore, knowledge discovery using information analysis techniques, On-Line Analysis Process (OLAP) and Link Analysis, is available for strategy analysis in the knowledge-based system of GOOD FINDER. OLAP access a multi-dimensional risk factors defined by a knowledge base to interactively analyze information and facilitate the decision-making process. Link Analysis uses charts to display the relationship among persons conducting financial transactions, their bank accounts, the amount of transactions, financial institutions involved and other related information in the knowledge-based system of GOOD FINDER. The valid relation obtained by combining the risk factors of customer and transaction from OLAP, link analysis and scenario analysis is implemented into a rule base of STR analysis and strategy analysis.

4. Design of the Knowledge-based system

Before entering a knowledge base design phase, we benchmarked other advanced FIU systems overseas, analyzed similar systems in banks, credit card and insurance companies, and performed the analy-

sis of international and domestic money laundering cases. The design of the knowledge-based system is a key contributor to its success. The knowledge-based system is composed of a rule based system and an inference engine. In addition, rule based representation is one of the widest known and implemented forms for knowledge representation in the development of the knowledge-based systems. Because production rules have a very simple syntax, they are easily understood. Their implementation offers a great degree of flexibility to the knowledge base as they are easy to modify and update (Matsatsinis, Doumpos, and Zopounidis, 1997). General expression of rule-based knowledge is shown in <Figure 4a>. In this case study, we use decision table representation scheme of rule-based knowledge as shown in <Figure 4b>.

If
    (type)
    and it is not true that (risk factor 1, condition 1)
    and it is true that (risk factor 2, condition 2)
    and {(risk factor 3, condition 3) or (risk factor 4,
       condition 4)}
Then
    Risk rating

(a) Rule

If				Then
risk factor 1	risk factor 2	risk factor 3	risk factor 4	
condition 1	condition 2	condition 3	condition 4	
False	True	True	True	Risk rating
			False	
		False	True	

(b) Decision Table

<Figure 4> Knowledge representation : Rule and Decision Table

The biggest problem in developing a knowledge base is the lack of experts and knowledge engineers, and difficulties with the extraction process of essential factors of rule and the rule itself. Especially, this has been called the knowledge acquisition problem and has been identified as a major bottleneck in the knowledge-based system development process (Wagner, Otto, and Chung, 2002). Several studies to elicit information from human knowledge have been proposed under the banner of knowledge acquisition to create knowledge base (Hayes-Roth, 1984a; 1984b; Cossick, Byrd, and Zmud, 1992). There have been a number of surveys regarding the various tools and approaches used in knowledge acquisition (Boose 1989, Kim and Courtney 1988, Holsapple and Wagner 1995, O'Leary, 1998).

Until now, an accurate methodology to detect and measure money laundering patterns in constructing the knowledge-based system still does not exist (Buchanan, 2004). In this case study, through the analysis of internal/external experts, case studies from overseas and domestic, study of STRs and analysis conclusion reports, typologies of suspicious transactions are defined and risk factors are deduced. In addition, since a lot of suspicious transactions with the relevant data, which is submitted by financial agencies to the KoFIU using a computerized system, are stored in the KoFIU, data is analyzed using statistical analysis, the t-test and stepwise selection method with fitting the logistic regression

model, to settle the typologies of suspicious transactions and to deduct the risk factors of them. These two methodologies are combined with knowledge acquisition process to design the knowledge base. Finally, inductive learning using C5.0 algorithms are used to create rules, and all of these design process of a knowledge base can be schematized as <Figure 5>.

Typology in this case study is categorized by transactions by a private person and a corporation. According to subjects to conduct transactions, three types of transactions in KRW and in foreign currency, respectively are defined. Especially the fact that all the domain experts in banks, insurance companies, securities companies, private banking, and foreign exchange co-worked with a knowledge engineer to design the knowledge-based system is very meaningful.

Various risk factors were deducted through data analysis and from expert through interview and survey. After composing IF statement with the combination of knowledge typologies and risk factors deducted from a quantitative and qualitative analysis, THEN statement is expressed by the risk rating of correspondent rules. Grading the level of risk of rules was based on the empirical ratio of provision to law enforcements. The rating structure of rules provides flexibility of analysis strategy and communication regarding risk rate between analysts in KoFIU. Risk rating has 4 levels. For example, level 1 means very suspicious and the ratio of provision
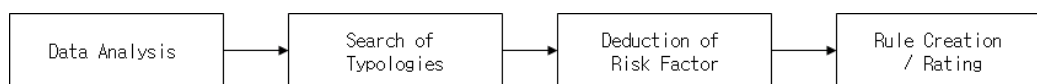
<Figure 5> Design process of Knowledge Base

to law enforcements is more than 90%. Rule expressed in this way is stored into the rule base of the knowledge-based system and it alerts transactions having that have the same conditions with IF statement in the rule.

5. Implementation and outcome of a knowledge base

The designed knowledge base is implemented using the business rule management software, JRules from ILOG. <Figure 6> shows the implementation framework. The ILOG Business Rule Management System (BRMS) framework provides Business Rule Engine (BRE) and editor. Additionally, it also provides the professional service including project resource management and application integration.

The main reason for selecting JRules to implement the knowledge base is as follows;

1. In rule-based system, programming skills are not required to create rules. Rules can be written in simpler languages used in the field. So it is simple, easy to implement and maintain the system.

2. Rules can be added, modified, and deleted without halting the system operation, so it has flexibility to handle the rapidly changing environment.

JRules in ILOG is implemented using JAVA. The main function of rule builder is rule authoring, rule deployment and rule management. Rule authoring is the process of rule-base model creation. Rule deployment is extracting rules from rule repository. Rule management is rule repository management. As shown in <Figure 6>, through the co-work of technical user and business user, rule is deducted and deducted rules are managed in repository and extracted when it is needed.

In <Figure 7>, it shows an illustrative knowledge representation in rule builder.

The outcome of the knowledge base implementation is shown in <Figure 8>. To measure the outcome, 17,922 STRs submitted from January 2007 to May 2007 were used. 360 of these were reported to law enforcements. Since the effective provision to law enforcements prevents money laundering as-
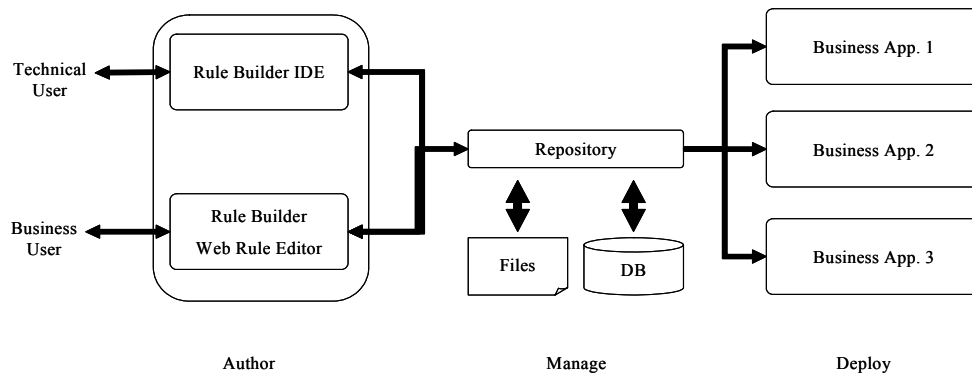
<Figure 6> Business Rule Management with ILOG JRules (ILOG, 2004)
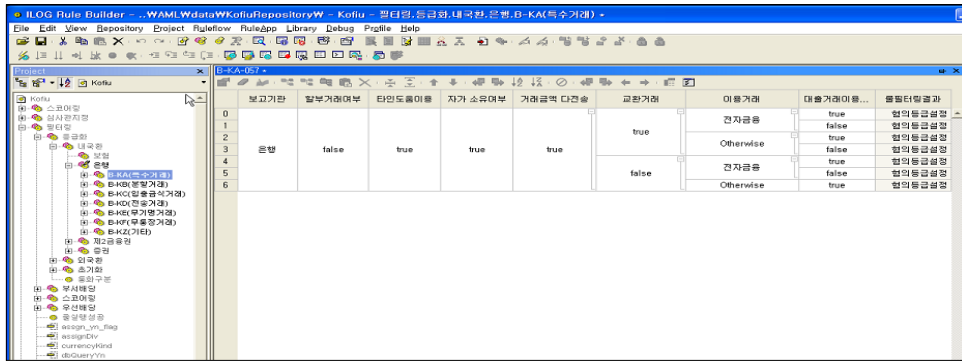
<Figure 7> An Illustrative Knowledge Representation in Rule Builder
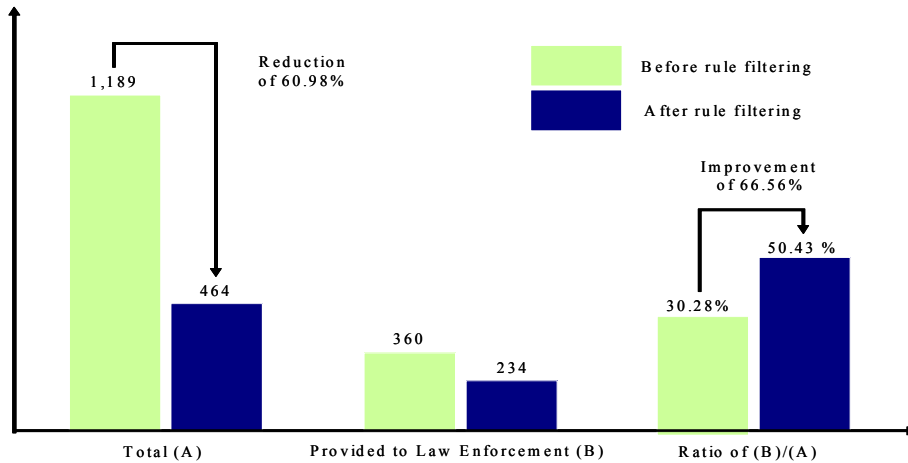
<Figure 8> Outcome of the Knowledge-based System

sociated with serious crimes and stops the illicit cross-border flow of funds that abuses the foreign exchange liberalization policy, the performance of the knowledge-based system in the KoFIU is evaluated whether GOOD FINDER identifies risky transactions among submitted STRs. The higher the ratio of provision to law enforcements for specific pattern of transactions is, the more risky the pattern of transactions is.

By application of the constructed knowledge-based system, 464 STRs were alerted out of 1,189 STRs, which shows a reduction of 60.98%. 360 cases of STRs were decided to be reported to law enforcements. Consequently, the ratio of STRs reported to law enforcements has increased from 30.28% up to 50.43% which is 66.56% of improvement. This is a meaningful figure showing the knowledge-based system is filtering STR in primary analysis step efficiently.

Apart from this quantitative outcome, the qualitative outcome is as follows. First, through the intelligent assignment in primary analysis, it can sup-

port filtering high risk transaction by grading the risk level of each transaction. This can resolve the bottleneck problem in the analysis process due to tremendously increasing STR. Second, it supports in-depth analysis by providing related statistical figure, key points and references for analysis, so it enhances the efficiency of STR analysis. Lastly, we establish a concept on the knowledge-based system, derive an appropriate framework supporting the concept, and set up development strategies. Since the analysts, consisted of experts from various ministries and agencies are assigned to their position in KoFIU on a regular basis, it is indispensable to organize, classify and group expert's know-how acquired from in-depth analysis into the knowledge base for anti-money laundering.

6. Monitoring and maintenance of a knowledge base

Unlike a typical transaction processing system, the knowledge-based system needs to be improved not only by the system administrator but also all the users, through participation in knowledge management activity. By the continuous monitoring of risk rating information, outdated knowledge needs to be deleted and brand new rules to handle most current money laundering type need to be added since this would affect the entire knowledge-based system performance.

Therefore, we provide the program for maintenance of the knowledge-based system which allows operations such as the viewing, modifying, removing, and adding of rules so analyst of KoFIU can adjust all the information of rules in GUI environment whenever required. Also for knowledge base management, the key success factor of the knowledge-based system, we advised to KoFIU that an independent department needs to be created.

Performance measure criteria are created and monitoring environment is provided. It is for adjusting rule base of the knowledge-based by monitoring risk factors and rule performance, so it can support making a decision on when to update rules in the system. <Figure 9> shows the detailed procedure of the rule base management in GOOD FINDER.
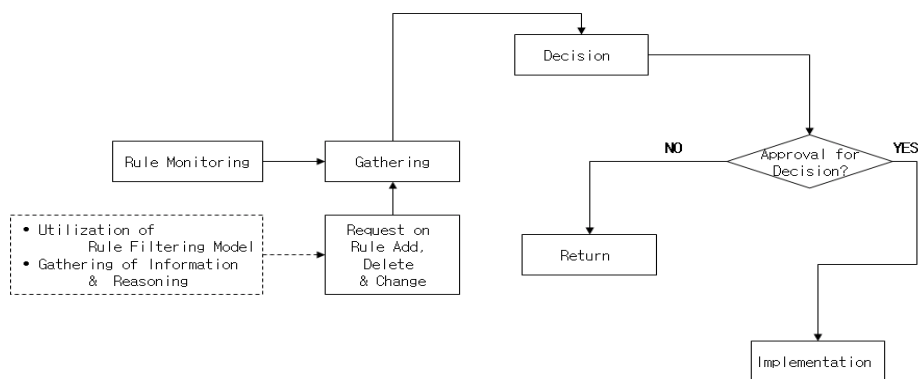
<Figure 9> The Procedure of Rule Base Management

7. Concluding remarks

This paper is the case study to apply a knowledge-based system for enhancement of GOOD FINDER. Through detecting high risk transactions and reporting them to law enforcements using the constructed knowledge-based system, it is possible to reduce the workload of GOOD FINDER. Simultaneously, there are conflicts with privacy law due to the convergence of a huge range of information into KoFIU. However after the analysis of reported STRs, only risky transactions are reported to law enforcements so innocent customer's personal profile and transaction information are secured. Since a huge range of information is converging into KoFIU, there are responsibilities to create of valuable knowledge related to money laundering. Through this case study, it can be said that establishing the foundation of the knowledge base under the entire framework of the knowledge-based system for consideration of knowledge creation and management in KoFIU is indeed valuable. In the future, if associations between risk factors or rules are extracted through other various analysis techniques and applied to the knowledge base, GOOD FINDER will be allowed to evolve into a more powerful, efficient, and reliable knowledge-based system.

References

Boose, J., "A Survey of Knowledge Acquisition Techniques and Tools", *Knowledge Acquisition*, (1989), 13～38.

Buchanan, B., "Money Laundering-A Global Obstacle", *Research in International Business and Finance*, Vol.18(2004), 115～127.

Chang, I. S., Understanding of Korea's Anti-money Laundering. Technical Report, Korea Financial Intelligence Unit (KOFIU), 2005.

Cossick, K. L., T. A. Byrd, and R. W. Zmud, "A Synthesis of Research on Requirements Analysis and Knowledge Acquisition Techniques", *MIS Quarterly*, Vol.16, No.1(1992), 117～138.

Hayes-Roth, F. D., Knowledge-Based Expert Systems. *IEEE Computer*, Vol.17, No.10(1984b), 263～273.

Hayes-Roth, F. D., "The Knowledge-Based Expert System : A Tutorial", *IEEE Computer*, Vol.17, No.9(1984a), 11～28.

Holsapple, C. and V. Raj, "An Exploratory Study of Two KA Methods", *Expert Systems*, Vol. 11(1994), 77～87.

ILOG, ILOG Jrules for developers. Customer education version, KSTEC Co., Ltd, 2004.

Kim, J. and J. Courtney, "A Survey of Knowledge Acquisition Techniques and the Relevance to Managerial Problem Domains", *Decision Support Systems*, Vol.4(1988), 269～284.

KPMG, "Global Benchmarking Report on Anti-money Laundering," Technical Report, Korea Financial Intelligence Unit (KOFIU), 2005.

Matsatsinis, N. E., M. Doumpos, and C. Zopounidis, "Knowledge Acquisition and Representation for Expert Systems in the Field of Financial Analysis", *Expert Systems with Applications*, Vol.12, No.2(1997), 247～262.

O'Leary, D. E., "Knowledge acquisition from multiple experts : An empirical study", *Management Science*, Vol.44, No.8(1998), 1049～1058.

Wagner, W. P., J. Otto, and Q. B. Chung, "Knowledge Acquisition for Expert Systems in Accounting and Financial Problem Domains", *Knowledge-Based Systems*, Vol.15(2002), 439～447.

Abstract

자금세탁방지를 위한 지식기반시스템의 구축 : 금융정보분석원 사례

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　본 논문은 금융기관을 이용한 자금세탁 및 불법적인 외화유출 방지를 목적으로 자금세탁 관련 혐의거래보고 등 금융정보를 수집하여 심사하는 금융정보분석원에 지식기반시스템을 도입한 사례연구이다. 한정된 심사인력으로 기하급수적으로 증가하는 혐의거래보고에 효과적으로 대응하기 위하여 지식기반시스템의 도입은 필수적이라고 할 수 있다. 이렇게 구축된 지식기반시스템은 보고된 혐의거래를 여과(filtering)하여 자금세탁혐의가 인정된 정보만을 수사기관에 제공하는 심사 및 분석 업무의 효과성과 효율성을 극대화시킨다.

　특히, 금융정보분석원은 여러 금융기관들로부터 보고된 혐의거래정보와 심사분석과정에서 유관기관으로부터 수집된 여러 종류의 정보가 집중되기 때문에 축적된 정보를 체계적으로 관리 및 활용할 수 있는 지식 베이스의 구축이 더욱 필요하다. 금융정보분석원은 많은 정보가 집중되는 만큼 축적된 데이터를 활용하여 자금세탁 관련 지식을 창출하는 업무를 수행해야만 하는 의무도 가지고 있기 때문이다. 이를 위하여 금융정보분석원의 심사분석시스템이 자금세탁방지를 위한 지식의 창출과 지식의 관리 측면까지 고려된 전체적인 프레임워크 하에서 지식기반시스템으로써의 토대를 마련하였다는 점에서 의의가 크다고 할 수 있다.

Keywords : 자금세탁방지, 지식기반시스템, 규칙기반시스템, 사례 연구

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신경식

지능형 의사결정지원시스템을 전공하고 이화여자대학교 경영학부에 재직 중이다. 미국 George Washington University에서 MBA, 한국과학기술원에서 경영정보학 박사를 취득하였고, 대우증권 국제부 애널리스트, 한국과학기술원 대우교수, University of Hong Kong과 National University of Singapore의 Visiting Scholar를 역임하였다. Decision Support Systems, Expert Systems with Applications, Lecture Notes in Computer Science 등 국제학술지에 10여 편의 논문을 포함하여 50여 편의 논문을 주요 학술지 및 학술대회에 발표하였으며, 발표된 논문 중 몇 편은 Decision Sciences Institute, 한국경영정보시스템학술대회, 한국지능정보시스템학술대회 등에서 최우수 논문으로 선정된 바 있다.

김현정

이화여자대학교 통계학사, 지능형 의사결정지원시스템으로 석사와 박사학위를 취득하고 현재 한국산업은행 리스크 관리본부에 재직 중이다. Applied Soft Computing, Expert Systems with Applications and Lecture Notes in Computer Science 등의 국제 저널에 논문을 게재하였으며, 주요 관심분야는 지식기반시스템, 데이터 마이닝과 인공지능 응용 등이다.

김효신

금융위원회 금융정보분석원에 재직 중으로, 자금세탁방지를 위한 심사분석시스템의 고도화 작업을 수행해 오고 있다. 정보처리기술사이며, 경희대학교 물리학사, 한국외국어대학교 대학원에서 경영학 석사를 취득하였고, 현재 성균관대학교 경영학 박사과정에 재학 중이다.