정보보안 소프트웨어 유지보수 대가기준을 위한 보정계수 산정에 관한 연구

A Study on an Estimation of Adjusted Coefficient for the Maintenance of Information Security Software in Korea Industry

박유진(You-Jin Park)*, 박은주(Eun-Ju Park)**

초 록

최근 정보보안과 관련한 심각한 사태가 발생하면서 정보보안에 대한 사회적 관심이 매우 높아지고 있으며, 사이버 보안 강화는 국가 및 기업의 인프라를 보호하고 경쟁력을 갖기 위해 중요한 부분이 되었다. 그러나 현재 국내 정보보안 소프트웨어 대가기준은 정보보안의 특수성은 배제된 채 일반 소프트웨어 유지보수의 기준으로 대가기준이 산정되고 있다. 따라서 현실에 맞는 적절한 정보보안 소프트웨어 유지보수 대가 산정 기준이 필요한 실정이다. 본 연구에서는 합리적이고 현실성 있는 정보보안 소프트웨어의 적정 대가기준 산정 방법을 제안하여, 사용자 및 공급자에게 적정한 대가 지급 기준을 수립함으로써 더 나아가 정보보안 소프트웨어 기업의 경쟁력 향상을 도모하고자 한다.

ABSTRACT

The maintenance prices in information security industry between Korean companies and foreign companies have been a big difference. Korea Information Security SW maintenance standards were not adequate for the rate, and there was disagreement between domestic companies and governments. This research, therefore, surveyed a standard of information SW and the status of maintenance payment rates. The study suggests an estimation method and verifies the method and an appropriate maintenance cost rate. According to the results of the study, the current maintenance cost should be increased or decreased independent with a kind of information security systems. Based on the study, Korea government is able to change the maintenance policy in information security. And the domestic companies get a theoretical ground for improving the rates of maintenance costs in information security systems and are able to allot the resources effectively.

키워드 : 정보보안 시스템 유지보수 비용, 유지보수 비용 추정, 현행유지보수 비용 분석, 소프트웨어 유지보수, 보정계수 산정
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* 주저자, 중앙대학교 경영경제대학 부교수
** 공동저자, 중앙대학교 경영학과 석사

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1. Introduction

As the recent emergence of societal problems relating to information security, the social interest in information security is dramatically growing, and the strengthening of cyber security has become a critical issue in protecting the national and corporate infrastructure as well as improving the national competitiveness. Such consistent interest in information security is leading to the investment on building the information system and protecting the infrastructure by the government and enterprise. However, Software Industry Promotion Act, especially in its Article 22 (Software Business Price Standards) as of now regulates that the parties concerned are to follow a 'mutual consultation', which causes such problems as the demand of indiscreet services by public sector. In order to deliver the information security software to public organizations, the certification cost for being recognized by Common Criteria (CC) Certification additionally is incurred, and the specificities of information security support service such as update and monitoring that are additionally required are excluded, which leads to inappropriate estimation of software maintenance standards. Thus it is needed to develop the cost estimation standards for the maintenance of information security software, which reflect the reality. The study aims to propose an appropriate compensation cost estimation method for information security software package that is reasonable and realistic. First of all, the author draws the implications by reviewing the previous literature and examining the current states, and attempts to calculate the costs based upon current maintenance cost standards and the costs based upon information security software maintenance activity specific cost estimation standards in order to establish the information security software response system, and ultimately suggests the maintenance cost calculation method by adopting the adjusted coefficient in the cost estimation comparison equation.

2. Research Background

First, "availability" means the characteristic of data, information and information systems being accessible and usable on a timely basis in the required manner [18]. Second, "confidentiality" means the characteristic of data and information being disclosed only to authorised persons, entities and processes at authorised times and in the authorised manner [18]. Third, "integrity" means the characteristic of data and information being accurate and complete and the preservation of accuracy and completeness [18].

The law on information security software maintenance cost estimation defines that the information security software is equivalent to general purpose software in its cost calculation, and the software cost standards (the Notification by the Ministry of Knowledge and Economy 2009-102) Software Industry Promotion Act, especially in its Article 22 (Software Business Price Standards) was enacted in order to facilitate the governmental bodies to utilize in its calculation of proper costs in case where such bodies undertake the budget plan, place a business order, or make a contract.

However, the cost standards for the maintenance of information security software are not established clearly yet, the law guides that parties concerned follow the calculation method based upon for calculation method depending on function point and the number and period of participating human resources for general purpose software. The maintenance cost rates are determined in the range of 10 to 15 percent of overall software cost calculated, and it has been notified that the rates are allowed to be adjusted. The calculation equation is established in a way that determines the characteristics of maintenance target system among simple, average, and complicated, and then estimates the Total Maintenance Point (TMP).

(1) Maintenance Difficulty(%) = 10 + 5 × Total Maintenance Point (TMP) ÷ 100

(2) Maintenance Cost = Maintenance Difficulty (%) × Calculated Software Development Cost

The current maintenance cost for information security software, which is the same as that of general purpose software package, that is, irrelevant to the characteristics of information security software, is set to the range between 10 and 15 percent of software development cost at the time when the maintenance is undertaken, upon the mutual consultation between the late movers. However, it is important that the 'mutual consultation' is often likely to be misused as poison pill that justifies the demand of maintenance service free of charge by public sector.

The service cost rate for the maintenance of software that requires consistent product upgrade, customizing, and educational and training services is at a similar level to the cost rate of hardware that merely requires simple maintenance for faults, and the maintenance service cost rate for domestic companies is about 10 percent, whereas that for foreign companies is about 22 percent, which explains that the public awareness on information security software by overall population is still quite low.

3. Information Security Software Maintenance Cost Calculation

The author attempts to build the cost calculation standard for information security software that applies the adjusted coefficient by estimating the maintenance cost and current maintenance cost in cost analysis and considering the adjusted coefficient that controls for the differentials between them in order to prepare for the maintenance cost standard for information security software.

3.1 Maintenance Cost Calculation

Due to the attributes of information security, new weaknesses, hacking techniques, viruses, spams, and warms are emerging, and the timely update that responds to the patterns of such attacks is in need, and there are needed manual technical services and regular basis supports that reflect the user situation in its update patterns as effective policy scheme. Unless the maintenance cost rate is in an appropriate level, the deterioration of domestic information security enterprise business profit as well as service quality is deepened, so that it is urgently needed to prepare for the proper cost calculation that takes it account the specificity of information security service.

3.1.1 Current Maintenance Cost Calculation

The product specific maintenance costs are categorized into three levels based upon the sales amount, particularly the product specific annual sales. Since the economic impact is likely to emerge differently depending on the sales scale specific to product made by enterprise, it is needed to calculate the maintenance compensation specific to proper product from various aspects.

The product sales unit price and maintenance cost rate for the estimation of current maintenance service cost are calculated based upon questionnaire survey, and the author conducts the product specific current standard maintenance cost analysis simulation.

The questionnaire survey was undertaken twice for information security software enterprises, and the first survey was sent on November 8 and received on November 19, and the second survey was sent on November 15 and received and returned on November 17 from the respondents.In the survey, the author tried to obtain the data on the product sales unit price and maintenance cost rate offered to government and enterprise by the company concerned as well as the average maintenance cost rate.

Current information security software maintenance cost is equivalent to that of general purpose software, and the figure is calculated in a way that multiplies the unit sales by maintenance cost rate. In order to estimate a more precise information security software maintenance cost, the author tries to calculate the activity specific cost analysis based maintenance cost.

3.1.2 Activity Specific Maintenance Cost Calculation

In the calculation of activity specific cost analysis based maintenance cost, the author analyzes the major maintenance activity in the information security field and draws the cost analysis method. In addition, the labor cost level is calculated through questionnaire survey, and the author undertakes the maintenance work cost analysis simulation for activity specific cost, which leads to the calculation of optimized maintenance cost. The activity specific cost categories for the calculation of information security software maintenance cost include supplementary development activity cost, pattern sustaining activity cost, QA activity cost, and technical service activity cost, and the information security software maintenance activities are categorized as the following <Table 1>.

〈Table 1〉 Description for Information Security Software Maintenance Activity

Major Maintenance Activity	Activity Concept Description
Pattern Maintenance	◦ SW Error Correction ◦ Version Patch
Certification	◦ Confirmation Process for Product Set Requirements ◦ Quality Warrant Plan Implementation, Evaluation, Correction, and Practice
Supplementary Development	◦ Newly Hacking Method Protection Technique Development ◦ SW Function Addition, Performance Improvement, Fault Supplement
Technical Service	◦ Technical Support Work System Process ◦ Everyday Support, Emergency/ Technical Problem Process ◦ Prevention/Prediction Support Customer-Tailored Support, etc.

Regarding the major activities for the maintenance of information security software program such as pattern sustaining, authorization, supplementary development, and technical service as well as other auxiliary activities, the author requested the enterprises concerned to respond to the questionnaire sheet that includes such information as the number of maintenance activity cases, average solution elapsed time per case with the unit of day, average human resources per case with the unit of person, and the level of expertise of human resources in need for each maintenance activity. Thus the equation illustrates the maintenance cost of information security software program as follows.

Σ(Number of Maintenance Activity Cases (per Month) × Solution Elapsed Time(Person/Month) × Labor Cost(KRW)

The labor cost in terms of the expertise of human resources that offer technical services was determined according to the cost criteria provided by Korea Software Industry Association, and this was divided into 8 levels from junior technician to intermediate grade engineer to senior engineer to professional engineer illustrated in the labor unit cost based upon software technician ranks depending on their technical qualification, educational level, and practical experience, and the Enforcement

Decree of the Software Industry Promotion Act of the Korean government in its Addenda 1 (Technical Grades and Extent of Recognition of Software Engineers in terms of technical qualification.

The calculation of information security software maintenance costs should be assessed in terms of adequacy depending on product, sales, and enterprise by the cost comparison based on the current maintenance compensation and base cost approach. The author chooses the target product category in order to apply the cost comparison simulation scenario. In this case, the author excludes the cases where the cost differential goes beyond 1000 percent between the current maintenance cost calculation standard price and activity specific maintenance cost calculation standard price as well as the cases where the answer on sales unit price information is omitted due to incomplete response by participating enterprise. In the simulation analysis, the author divides the cases into those cases where activity cost is higher than current standard and the other cases where current maintenance cost is higher than activity specific maintenance cost.

Since the gap between current information security software maintenance cost and activity specific maintenance cost calculation equations is needed to additionally adjusted and the adequate calculation of information security software maintenance cost is in need, the calculation of actual necessary maintenance cost through the comparative analysis on maintenance cost rate was undertaken by the repetitive simulation of optimal maintenance cost.

3.2 Learning Curve

Different working attitude, mechanization, and skill are caused in different companies according to learning effect, and thus the learning curve is applied in the calculation of adjusted coefficient [15]. It is widely known that there is a constant relation between experience and efficiency and the unit production time decreases in an exponential function in the equivalent work [17]. Meanwhile, the initial relation does not necessarily remain unchanged, but the rate of change increases to a certain period or production quantity, and the reduction rate of cost slow down reaching a certain level.

In a Learning Curve Primer for Software Engineering, the learning rate is shown to be 80 percent when the working days for software engineers are accumulated [19]. In this sense, the maintenance activity for information security software also takes the shape of learning curve, and the learning curve emerges in a way that reduces the time elapsed to have the problem solved once each activity takes place.

By using the equation for learning curve of $C_k = C_1 \cdot x^b$, the author calculates the cost and cost rate by learning rates [7]. The author

〈Table 2〉 A Family of Learning Curve Equations

Learning Curve	Equation	Description
Log-Linear	$Y=a(x)^q$	The Log-Linear curve suggests that the same learning rate occurs throughout the entire process.
DeJong	$Y=a[M+(1-M)(x)^q]$ $Y=a+b(x)^q$	The DeJong curve has been used effectively in factories, where the equipment on the assembly line ultimately limits productivity.
Stanford-B	$Y=a(x+b)^q$	There are two common interpretations of the Stanford-B curve. In the first interpretation, the Stanford-B curve models processes where some learning carries over from previous processes, so workers start out more productively than the asymptote predicts. The second interpretation of the Stanford-B learning curve suggests that learning may take a while to start.
S-Curve	$Y=a[M+(1-M)(x+b)^q]$ $Y=a+b(x+c)^q$	The S-Curve combines the behavior of the Stanford-B and DeJong curves to model processes where learning carries over from one process to the next and the process contains activities that do not improve.

attempts to draw the learning rate cost by applying the concept of such learning curve, and the cost calculation equation specific to product activity that applies the learning curve is shown as below.

Product Activity Specific Cost = {Labor Unit Cost (Day) × (Case × Time Elapsed (Day))^0.8} × Number of Persons (Person).

3.3 Adjusted Coefficient

Adjusted coefficient is defined as the value that is calculated around the elements available in the budget planning and proposing stages and quantifiable among the complexity elements since it is difficult to calculate the precise cost for business merely based on the scale of software [3]. In the software development cost standard, the method that determines the software scale by Functional Size Measurement (FSM) or Lines of Code (LOC) in an appropriate manner in calculating the development scale is used in the estimation of adjusted coefficient, and there is a method that adjusts and calculates the value according to the characteristics of development and application environment [20].

3.3.1 Adjusted coefficient Model

The existing model specific studies on adjusted coefficient include COCOMO model [12], IFPUG model [16], Albrecht model [8, 9, [17], and Symon's Mark Ⅱ, and each model suggests a wide range of adjusted coefficients. Since the model covers from the software development to management and operation, that is, every aspect of software application, the study attempts to apply the quality assessment model of ISO/IEC 9126, which is the software quality management standard and then calculate the adjusted co-efficient for information security software maintenance.

The following <Table 3> illustrates the

〈Table 3〉 Relevance of Adjusted Coefficient

ISO/IEC 9126 Quality Model Revisited		Existing Model Relevance		
Category	Assessment Item	COCOMO	IFPUG	Albercht Model
Functionality	Output Precision	◦ Artificial Machine Variability ◦ Main Memory Device Constraint ◦ Response Time	◦ Data Communication ◦ Distributed Process ◦ Performance ◦ Hardware Constraint ◦ Processing Rate	◦ Data Communication ◦ Functional Distribution ◦ System Performance
	Implementation Efficiency			
Usability	Learning Performance	◦ Implementation Time Constraint	◦ Operation Easiness ◦ End User Easiness ◦ Online Data Input	◦ Interface Complexity ◦ Online Data Input ◦ Operation Environment
	Error Prevention and Usage Consistency			
	Interface Fitness			
Maintainability	Expression Fitness	◦ Cutting-Edge Programming Usage ◦ Software Tool Usage ◦ Computer Stability	◦ Modification Easiness ◦ Online Renewal ◦ Operation Complexity	◦ Online Data Renewal ◦ Online Processing ◦ Processing Complexity ◦ Maintenance Easiness
	Program Structuralization			
	Module Stability			
	Module Annotation Usefulness			
Transplantability	Extension and Communication Exchangeability	◦ Product Complexity ◦ Application Experience ◦ Development Language Experience	◦ Installment Easiness ◦ Reusability	◦ Installment Easiness ◦ Reusability ◦ MultipleInstalla bility
	Acceptance test and Operability			
	Telecommunication and Data Shareability			
	Reusability			
Information Security Attributes	Update	◦ Additional Items		
	Certification			

relevant contents to the models concerned. The adjusted factors and corresponding operational definitions for the calculation of information security maintenance costs based upon the above facts are proposed as the following <Table 4>.

〈Table 4〉 Operational Definition for Adjusted Factor of Information Security Software

Assessment Categories		Operational Definition
Functionality	Output Precision	Desired Standard, Consistently Matched Outcome, and Correct Result Showing Software Related Attributes
	Implementation Efficiency	System Environment Specification, Response Time, Processing Speed, and Processing Performance Related Attributes
Usability	Learning Performance	Time Elapsed to Process a Certain Function and Processing Rate Related Attributes
	Error Prevention and Usage Consistency	Input Method, Screen Output, System Response Consistency and Error Correction Easiness, Error Message Usefulness Related Attributes
	Interface Fitness	User Interface Fitness to User Level Related Attribute
Maintainability	Expression Fitness	Input and Output, Processing Logic, and Simplicity Based Functional Understanding Related Attributes
	Program Structuralization	Exclusion of Program Structure Ambiguity, Structured Language Usage, Control Flow Complexity, Code Complexity Related Attributes
	Module Stability	Module Integration Degree, Module Relevance, Module Function and Scale Fitness (Number of Program Lines) Related Attribute
	Module Annotation Usefulness	Module Annotation Amount and Annotation Usefulness, Attribute that Implies the Degree to which Expressiveness of Language Used
Transplantability	Extension and Communication Exchangeability	Attributes That Relate to the Addition of System Functions and Facilitate the System Output and Easy Construction of Error Notification Messages
	Acceptance test and Operability	Attributes That Relate to the Sufficient Awareness of User Demands, Implementation, Initiation, Operation, and Termination of System
	Telecommunication and Data Shareability	The Degree to Which Communication Protocols, Data Formats, and Expressive Structures Commonly Shared by Systems
	Reusability	The Degree to Which Modules are Widely Utilized and Compatible to Other Systems
Information Security Attributes	Update	Consistent Product Supplement Update Attribute for Assuring the Information Security
	Certification	Reliability Assured Product Authorization Related Attribute

3.3.2 Adjusted Coefficient Calculation Process

Adjusted coefficient is calculated in a way that follows. First, the calculation begins from the analysis stage on the relative difficulty of adjusted element. The author applies the AHP analysis method upon the collected data from the questionnaire survey towards the enterprises, and then estimates the analyzed values specific to adjustment elements. Second, the author undertakes the relative difficulty index calculation process for adjustment elements. Based upon the minimum value among the adjusted element values according to their relative difficulty, the author applies the point relating to its relative difference. The relative difficulty index is used in the calculation of the weight proportionate to the actual level of difficulty once the adjusted elements are applied. Third, the next stage is relating to the determination of relative importance of each adjustment element. It is needed to calculate the analysis value specific to adjustment element by applying the AHP analysis on the collected data from the questionnaire survey. Fourth, then the author determines the differential value depending on the level of difficulty of adjustment elements. In the maintenance activity, the author estimates the difference values according to the difficulty level among high, intermediate, and low based on the elements adjusted, and this utilizes and applies the relative difficulty and relative importance levels obtained in the stage 2. Fifth, the stage leads to the application of weight value to the adjustment element differential values. The adjustment element weight is applied as the differential caused by the difficulty of adjustment elements and related to the application of weights to actual analysis at this stage, and the maximum, average, and minimum values as well as adjusted element differential values are applied and calculated for the difficulty index specific to adjustment elements.

Sixth, the stage attempts to calculate the adjusted coefficient. Adjusted coefficient is likely to differ according to the difficulty level of adjustment elements, and the author calculates the values in each case where all the adjustment elements are high, intermediate, and low in terms of difficulty.

4. Analysis and Result

4.1 Simulation Analysis

The process of calculating the information security maintenance costs consists of the comparison between the current maintenance costs and the activity specific information security maintenance costs and the application of adjusted coefficient, which leads to the estimation of optimized cost. First of all, the cost comparison simulation tries to match each cost rate of 8, 10, 12, 14, 16, 18, and 20 percent to each product category. The simulation is undertaken in order to obtain the optimum point in the 49 scenarios of the current maintenance costs and 7 scenarios of the activity specific maintenance costs. Next, the stage of calculating the optimal cost level to which the adjusted coefficient is applied consists of the stage that calculates the adjusted coefficient for the proposed optimal point in the simulation, and the author discovers the adjustment elements by expert survey.

4.2 Simulation Result

Thus the study tries to calculate the current maintenance costs for each product category by applying each cost rate level ranging from 8 to 20 percent to the product specific sales unit prices in a way that follows the current maintenance cost standard method. In addition, the author calculates activity based maintenance costs specific to product by applying the number of activity based maintenance cases, solution elapsed time, number of person in need for maintenance, and learning curve in a way that follows the maintenance cost standard method for each product and activity. Then the author analyzes the difference and differential price between the higher values among activity based costs and the current costs through the simulation work on the two types of costs. Lastly, the author finds out the adjusted coefficient that applies the relative difficulty and importance obtained in the questionnaire survey in order to adjust and control for the price difference and estimate the proper maintenance cost level. The simulation results on optimal adjusted coefficient are summarized as follows.

〈Table 5〉 Summary of Optimal Adjusted Coefficient Simulation

Cost Differential Standards	Standards	Company (Names Omitted)	Current Rate-Specific Necessary Adjusted Coefficient						
			8%	10%	12%	14%	16%	18%	20%
Higher Activity Costs Compared to Current Standards	DB/Contents Security	A_1	0.5	0.6	0.7	0.9	1.0	1.1	1.2
	Access Management	A_2	0.7	0.8	1.0	1.1	1.3	1.5	1.6
	Intrusion Prevention System	A_3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
Higher Current Standards Compared to Activity Costs	Integrated Security System	B_1	2.5	3.1	3.7	4.3	4.9	5.5	6.2
	DB/Contents Security	B_2	4.0	5.0	6.0	7.0	8.1	9.1	10.1
	Access Management	B_3	3.1	3.9	4.7	5.5	6.2	7.0	7.8
	Intrusion Prevention System	B_4	2.4	3.0	3.6	4.2	4.8	5.4	6.0

5. Conclusion

In this study, the author attempted to estimate the adjusted coefficient in order to propose the appropriate level of information security software maintenance service cost standard by reflecting the specificity of information security. The simulation analysis revealed that it is appropriate to offer the maintenance service cost in the range of 14 to 18 percent of the current maintenance cost calculation standard in case where activity cost is higher than current standard, whereas the simulation result explained that it is appropriate to offer the maintenance service cost in the range of approximately 8 percent of the current maintenance cost calculation standard in case where the current maintenance cost is higher than activity specific maintenance cost.

Then the author determined the appropriate level of cost rate in both cases where activity cost is higher than current standard and current maintenance cost is higher than activity specific maintenance cost by distinguishing the maintenance cost calculation standards into activity cost and current maintenance cost. There is a limitation that the author suggests 7 types of product groups finally, and thus it covered limited range of information security product categories.

The study has an implication that it secures the stability of knowledge information assets by drawing the standardized frame scheme for calculating the information security software maintenance service cost in a national policy aspect, and proposes the policy direction for establishing the draft for calculating the information security software maintenance service cost as well as leads the changes in public awareness on information security software. Especially by software product consumers in a demand aspect, which contributes to the systematic management of the information security software maintenance service by enterprises and establishing the standardized frame for calculating the information security software maintenance service cost. In addition, it is expected that the establishment of standardized frame scheme for calculating the information security software maintenance service cost and estimation of appropriate level of compensation cost lead to the actualization of maintenance service cost rate and the improved service quality as well as the promotion of excellent product development.

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저 자 소 개

박유진 (E-mail : eugenepark@cau.ac.kr)
Arizona State University 산업공학 (박사)
2007년 9월~현재 중앙대학교 부교수
관심분야 생산관리, 경영예측, 산업공학

박은주 (E-mail : ejlm2000@hanmail.net)
2010년 협성대학교 경영학과 (학사)
현재 중앙대학교 경영학과 (석사과정)
관심분야 정보보안, 유지보수, 유통경영, 창업