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IMPROVING THE COST INFORMATION MANAGEMENT SYSTEM: THE CASE STUDY OF DEFENSE MATERIALS INDUSTRY IN KOREA

This study shows how to develop and apply an objective cost equation model through accounting engineering approach with the focus on indirect processing costs. The authors provide a cost estimation method that can be used by both government and contractors to predict and calculate reasonable processing costs acceptable by both parties. By applying the suggested approach, both parties can utilize the future estimated cost or target cost as a basic cost for planning, budgeting, bid pricing and contract pricing.

Keywords: *defense sector; private contractors; cost management; indirect cost; ceiling price; target cost.*

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МОДЕРНІЗАЦІЯ СИСТЕМИ УПРАВЛІННЯ ІНФОРМАЦІЄЮ ПРО ВАРТІСТЬ: НА ПРИКЛАДІ СЕКТОРУ ОБОРОНИ ПІВДЕННОЇ КОРЕЇ

У статті представлено розроблену авторами модель об'єктивної вартості з акцентом на непрямих витратах на обробку. Запропоновано метод, що може бути використаний як державою, так і підрядниками для прогнозування та розрахунку обґрунтованих витрат на обробку, які були б прийнятні для обох сторін. У такому випадку обидві сторони могли б використовувати планову вартість як базовий параметр при плануванні, бюджетуванні, встановленні цін на тендерах та при підписання контрактів.

Ключові слова: *сектор оборони; приватні підрядники; управління вартістю; непрямі витрати; максимально припустима ціна; планова вартість.*

Форм. 13. Рис. 5. Табл. 5. Літ. 13.

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МОДЕРНИЗАЦИЯ СИСТЕМЫ УПРАВЛЕНИЯ ИНФОРМАЦИЕЙ О СТОИМОСТИ: НА ПРИМЕРЕ СЕКТОРА ОБОРОНЫ ЮЖНОЙ КОРЕИ

В статье представлена разработанная авторами модель объективной стоимости с акцентом на непрямых затратах на обработку. Предложен метод, который может быть использован как государством, так и подрядчиками для прогнозирования и подсчёта обоснованных затрат на переработку, которые были бы приемлемы для обеих сторон. В таком случае обе стороны могли бы использовать плановую стоимость как базовый параметр при планировании, бюджетировании, установлении цен на тендерах и при заключении контрактов.

Ключевые слова: *сектор обороны; частные подрядчики; управление стоимостью; непрямые затраты; максимально допустимая цена; плановая стоимость.*

Introduction. The gross defense budget in Korea is about 35 bln USD (as of 2014), of which about 10 bln USD are expected to be used for acquisition or development of new weapons and/or for general defense improvement. Korea exports about 2.8 bln USD of defense products annually and is ranked among top-15 exporters in the world. International defense market is very competitive and Korean

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defense industry has been competing against other countries based on the cutting-edge technologies.

Unlike other products, defense products have limited demand and long payback period. The price, in defense market, is typically determined not by the basic law of supply and demand but by manufacturing costs and national defense budget allowance. Also, fluctuation of the required amount of products may result in either excess of production capacity, or idle facilities. And sometimes, the reliability of products can outweigh economic feasibility.

Thus, most of defense contracts are private contracts or cost reimbursement contracts and the price is determined by negotiation based on actual manufacturing costs incurred by contractors. Therefore, the accurate cost management system is very important. Many Korean defense contractors, however, show weak performance in quality efficiency partly due to low productivity and their profit structure which is centered on domestic sales. Table 1 shows the productivity of defense contractors in Korea as compared to general manufacturing.

Table 1. **Comparison between domestic defense contractors and manufacturing industry overall** (DAPA, 2013)

	Return on equity, %	Sales per capita, mln USD	Rate of operation, %	Operating profit percentage, %	Technology level, %
Domestic defense contractors	8.1	2.4	57.8	3.79	67
Industry	12.2	0.5 (all defense industry)	79.8	6.8	80

Besides, there has been mistrust and complaints between the Defense Acquisition Program Administration (DAPA), a government agency in Korea, and defense contractors regarding cost calculations and contracts. Such problems arise not only from the lack of mutual understanding but also from the cost management system itself. The current cost management system does not clearly define cost standards and does not reward contractors for cost savings. Therefore, government should develop a more reliable cost management system that is transparent and predictable; defense contractors should strive for better cost management system and saving cost by eliminating irrational elements to improve global competitiveness.

The paper introduces a new cost accounting system for defense contracts and proposes an improved cost information management system to provide a fair cost calculation to defense contractors and to guarantee them a reasonable compensation by the government. The paper also analyzes the cost data from 3 defense contractors in Korea with the focus on indirect processing of costs and profits. This study then apply the proposed method to incentive contracts to show how to improve work standards and efficiency. The proposed study, in practice, may help reduce the mistrust by both the government agency (e.g., DAPA) and contractors by showing a reasonable price which is mutually agreeable.

Cost accounting system for defense contracts in Korea. Cost accounting system for defense contracts in Korea has made continuous progress by the efforts of personnel in the defense industry. Since the introduction of "The Standard and

Guidance for Calculating the Price of Defense Industry Goods" in 1974, the cost and contract system for defense products has been revised many times to reach its present form. As competition increases, cost standards for defense industry have been changed to match general accounting system (K-IFRS) by improving rationality in cost management. The most common method of contract for defense materials in Korea is a private contract. For this, there has been increasing efforts to reward cost reduction and implement a more precise settlement timeframe.

Features and problems of the current cost calculations in Korean defense industry are as follows:

First, Korean government procures defense articles from designated contractors. As a result, more than 95% of defense articles are purchased through private contracts and the contract price is determined based on actual costs provided by contractors. For maintenance products, specific-item un-confirmed contract is mainly used because it is almost impossible to confirm the cost in advance.

Second, cost calculations are based mostly on direct labor costs. By following the Regulation on the Cost Accounting of Defense Materials, defense contractors categorize cost as direct material, indirect material, direct labor, indirect labor, direct expenses, and indirect expenses. Unlike general corporate accounting standards, the defense industry separates direct expenses and both indirect labor and indirect expenses are calculated by ratios based on direct labor costs.

Third, DAPA determines and applies ratios for all indirect costs and these ratios are used in advance for cost calculations. For example, based on the "Regulation on the Cost Accounting of Defense Materials", indirect labor cost are calculated by multiplying current year's direct labor costs and DAPA's indirect labor ratio. Similarly, indirect expenses are calculated by multiplying current year's accrued direct expenses and indirect expense ratio. One unique system in Korea is compensation. There are 4 different types of compensations developed by DAPA in Korea: compensation for invested capital, basic compensation, compensation for efforts, and risk compensation. Compensation for the invested capital is calculated by multiplying invested capital and compensation ratio; basic compensation is calculated by multiplying basic compensation ratio and total cost which includes materials costs provided by the government that are used in manufacturing process.

Compensation for efforts is to provide an incentive to contractors for their efforts to improve their management system, quality management, cost reduction, the investment in plant and equipment, and performance under the contract. It is, however, not a compensation for their actual effort because it is determined by the multiplication of invariable ratio and accounts in financial accounting.

There are two kinds of risk compensations: technical risk compensation and contract risk compensation. Technical risk compensation is calculated by multiplying different compensation ratios to total cost. The ratio is determined after considering risk levels for each contract: high risk contracts receive relative high compensation ratios. Contract risk compensation covers for the risk by defense contractors for implementing the contract. It is determined after evaluating the risks which defense contractors take and different ratios are applied according to contract types.

Table 2 shows the rates for technical and contract risk compensations.

Table 3 which shows the cost structure for defense contracts in Korea.

Table 2. **The rates for technical & contract risk compensations,** *authors'*

Technical risk compensation, %			
Classification	R&d	Initial/succeeding production, maintenance	Technology introduction
Compensation Rate	1.5	0.75	0.5
Contract risk compensation			
Contract type			Compensation rate, %
Firm fixed price contract, incentive fixed contract, adjusted-price unit contract, cost reduction compensation contract, specific-item un-confirmed contract (when the approximate cost is more than 75% of the total cost), basic ordering agreement			3
Incentive cost adjustment contract, specific-item un-confirmed contract (when the approximate cost is more than 50% of the total cost)			1.5
Interim fixed contract, specific-item un-confirmed contract (when the approximate cost is less than 50% of the total cost)			1

Table 3. **Cost structure for defense contracts in Korea,** *authors'*

<table>
<tr><td colspan="3"></td><td>*Other compensations</td><td rowspan="2">Contract price</td></tr>
<tr><td colspan="3"></td><td>*Compensation for the invested capital</td></tr>
<tr><td colspan="2"></td><td>*General and administrative expenses</td><td rowspan="5">Total cost</td></tr>
<tr><td colspan="2">Indirect expenses</td><td rowspan="4">Processing cost</td></tr>
<tr><td colspan="2">*Indirect labor costs</td></tr>
<tr><td colspan="2">*Indirect materials costs</td></tr>
<tr><td>Direct expenses</td><td rowspan="3">Direct cost</td></tr>
<tr><td>Direct labor costs</td></tr>
<tr><td>Direct materials costs</td></tr>
</table>

The ratios are calculated by a cost management team every year and are distributed by industries.

Considering features and problems of the current system, DAPA should reevaluate profit/compensation methods and promote defense industry by applying more advanced cost reduction and incentive contract system. DAPA should also vitalize more incentive-based contract methods like incentive fixed-price cost calculation or incentive commissions plus cost calculation to get a range of target cost.

We propose an improved cost information management system to provide a fair cost calculation to defense contractors to guarantee contractors reasonable compensation by the government. The main point of the proposed system is that: 1) normal profit/compensation should be used if the cost is within the target range; 2) incentive compensation (positive or negative) should be applied for the cost outside the target range. The following shows the suggested formula:

$$Normal\ profit = Accrued\ cost \times Profit\ ratio\ by\ each\ company\ (contract). \quad (1)$$

Incentive profit:

1) if accrued cost is smaller than the lower limit of the target range, then pay incentive profit. That is:

$$Incentive\ profit = (Lower\ limit\ of\ the\ target\ range - Accrued\ cost) \times Ratio\ (confirmed,\ 50\%;\ cost\ adjustment,\ 90\%); \quad (2)$$

2) if accrued cost is greater than the upper limit of the target range, then penalize. That is:

$$Incentive\ profit\ (penalty) = (Accrued\ cost - Upper\ limit\ of\ the\ target\ range) \times Ratio\ (confirmed,\ 50\%;\ cost\ adjustment,\ 90\%); \quad (3)$$

3) if the accrued cost is within the lower and upper limits of the target range, then the incentive profit is equal to zero.

Table 4 summarizes the proposed calculations.

Table 4. **Methods for profit calculations,** *authors'*

Accrued cost	Cost compensation	Profit payment	Remarks
Within the target range	Accrued cost acknowledgement	$Accrued\ cost \times Profit\ Rate$	Settlement contract
Outside the target range		$Accrued\ cost \times Profit\ Rate + Incentives(+,-)$	Incentive contract

Improving the cost calculation method in defense contract is critical. It is important to understand cost behavior to make various cost-related decisions. Based on its behavior, cost can be categorized as either fixed, or variable one. Fixed cost is constant, in total, regardless the activity level but the unit fixed cost decreases as the activity level increases; variable cost increases, in total, as the activity level increases but the unit variable cost is constant regardless the activity level.

By following the cost behavior, we reclassify the cost of defense articles as either fixed, or variable and then rename direct labor and direct expenses as direct processing cost; indirect labor and indirect expenses as indirect processing cost. After that we calculate cost by applying a similar cost compensation method which is based on actual cost as discussed before.

Next we apply cost-volume-profit analysis to find solutions to improve the current direct labor-based costing system and various ratio-based cost calculations. One way of doing the analysis is using a graph. CVP graph shows the activity level on the X-axis and the sales revenue and total costs on the Y-axis. The graph shows how profits and costs are changing as the activity level changes. Figure 1 shows his graph.

Application of the proposed method on the incentive cost contract.

The basic concept of the proposed approach to improving the calculations of indirect processing cost. The basic direction for the improvement on cost calculation methods in defense contract has focused on the accrued costs based on the appropriate business accounting principles with special consideration of the defense industry. But cost is the result of not only production but also general management activities and therefore both cost factors and their appropriateness should also be considered. The

reliance on past data to determine present cost may weaken the efforts for technology development and/or management innovation. Table 5 summarizes the differences between the current problems and the proposed alternatives to improve the calculations of indirect processing cost.

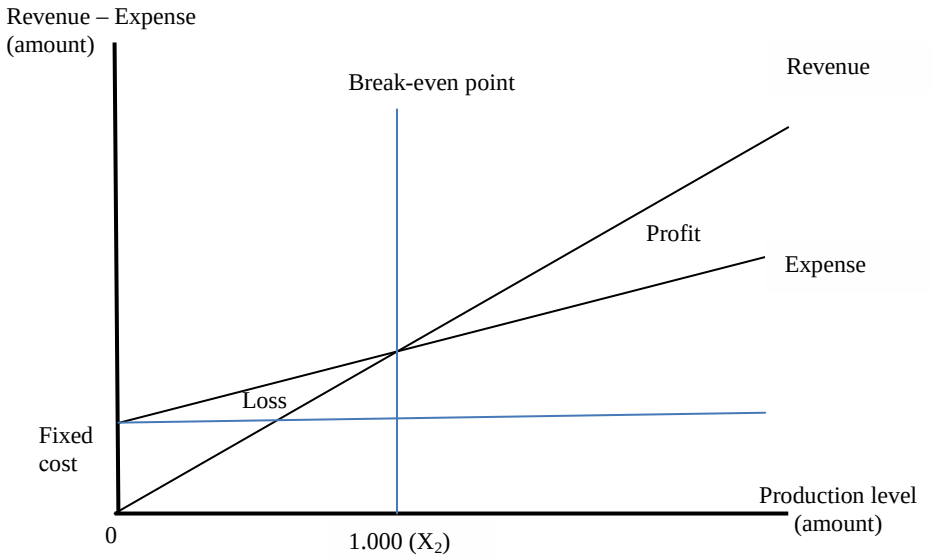

Figure 1. **Cost-volume-profit graph,** *authors'*

Table 5. **The proposed improvement in calculating indirect processing cost,** *authors'*

Classification	Current problems	Proposed alternative
Concept	Application of the past indirect processing cost ratio on current project	Determined by cooperation and negotiation after evaluation of the production volume and indirect processing cost
Timing	Beginning of year in advance	When contract is signed
Application	One ratio for each contractor	Different ratios for different products or contracts
Assessing department	Dualization of calculation	Controlled in bulk by contracting department
Method	Out-of-spot evaluation of the basis	Rational distribution basis after confirming on-the-spot evaluation (based on cost variance)

Application of the improved method based on incentive cost contract. The fixed price contract based on incentive is designed to motivate contractors reduce cost when calculation of the fixed price is difficult due to uncertainties. The method tries to induce cost reduction effort from contractors by allowing them get more (less) profits when the accrued cost is less (greater) than the target cost agreed by parties when the contract is signed. The following conditions should be agreed when both parties make a contract.

- Target cost (*CT*): The expected amount of actual cost with reasonable probability.
- Target profit (πT): Profit both parties agreed upon.

- Ceiling price (*CP*): The maximum price that can be paid to the contractor.
- Government-to-contractor sharing ratio (Sharing Ratio: ?): The ratio that splits between the government and the contractor when the accrued cost is different from the target cost.

The target price (*PT*) is the sum of target cost and target profit; accrued cost should be confirmed by audit firms and be agreed by both parties after contract termination. Then, this study can derive the following equation:

$$Ceiling\ price\ (CP) = Final\ price(Pf) = Final\ profit(\pi f) + Final\ cost(Cf). \quad (4)$$

And, $$\pi f = \pi T + \alpha \times (CT - CF). \quad (5)$$

So, $$CP = Cf + \pi T + \alpha \times (CT - CF). \quad (6)$$

If we rewrite the equation, then $$(1-\alpha)CF = CP - \pi T - \alpha \times CT. \quad (7)$$

Therefore, the final cost is:

$$CF = \frac{CP - \pi T - \alpha \times CT}{1-\alpha}. \quad (8)$$

In other words,

$$Ceiling\,cost = \frac{Ceiling\ price - Target\ profit - Target\ cost \times Sharing\ ratio}{1 - Sharing\ ratio}. \quad (9)$$

The ceiling cost is the point that makes the contract the same as a fixed price contract with the ceiling cost as the fixed price.

$$Sharing\,ratio(\alpha) = \frac{Profit\ \ pool}{cost\ \ range} = \frac{\pi T - \pi C}{Cc - CT} = \frac{OG - OF}{OD - OC} = \frac{GF}{CD}. \quad (10)$$

$$Cost\,range = ceiling\,cost - target\ cost = CC - CT = OD - OC = CD. \quad (11)$$

$$Profit\ pool = target\ profit - appropriate\ profit\ at\ point\ \ of\ total\ assumption.$$

$$(PTA)^{*} = \pi T - \pi C = OG - OF. \quad (12)$$

$$^{*}PTA(Point\ of\ Total\ Assumption) = Cc.$$

$$CP = OE = OD + DE, \text{so}, CP = Cc + \pi C. \quad (13)$$

Therefore, if *Cc* & πC are determined through negotiation, then CP is calculated automatically. This relationship is proved by the cost-profit graph in Figure 2.

Let us examine how the relationship works using numbers in the fixed price contract based on incentive. When $\alpha = 0.5$, if the target cost is 239.940, target profit, 47.980, ceiling price, 320.000, and sharing ratio is 50/50, then the ceiling cost becomes 304.100 according to the formula derived earlier. If the accrued cost by the contractor is 219.940, then it is less than target cost by 20.000 which will be distributed equally to the contractor and the government. Then, the contractor will get the total profit of 57.980 which is the sum of target profit (47.980) and distributed saving (10.000). Then government will pay the contractor 277.920 (accrued cost of 219.940 contractor's total profit of 57.980) and save 10.000 from the target contract price of 287.920. The opposite can be true if the accrued cost is greater than the target cost. Figure 3 shows the relationship.

Application of the proposed approach in the incentive contract based on fees. This method is designed to induce contractors reduce costs when both parties can agree to

the target cost even though there are big uncertainties in cost calculations. It compensates the problems of the fixed fee cost adjustment method which does not have any incentives for contractors to reduce costs. The basic concept is similar to that of incentive fixed price contract, but tries to induce cost reduction efforts from contractors by applying different fees depending on the actual cost occurred by contractors. It is fundamentally different from the incentive fixed price provisional contract in terms of fixed price and post adjustment of cost. Figure 4 shows the relationship.

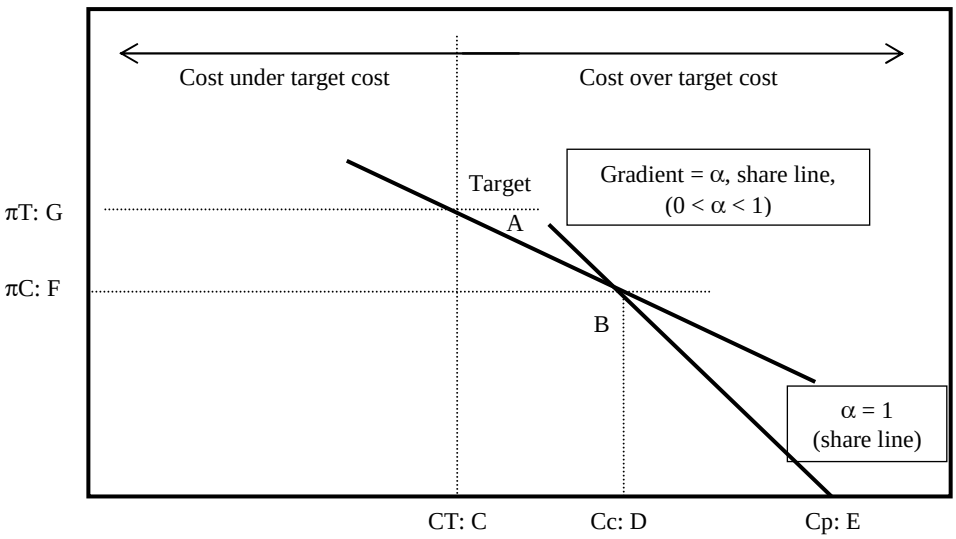

Figure 2. **Cost-profit diagram,** *authors'*

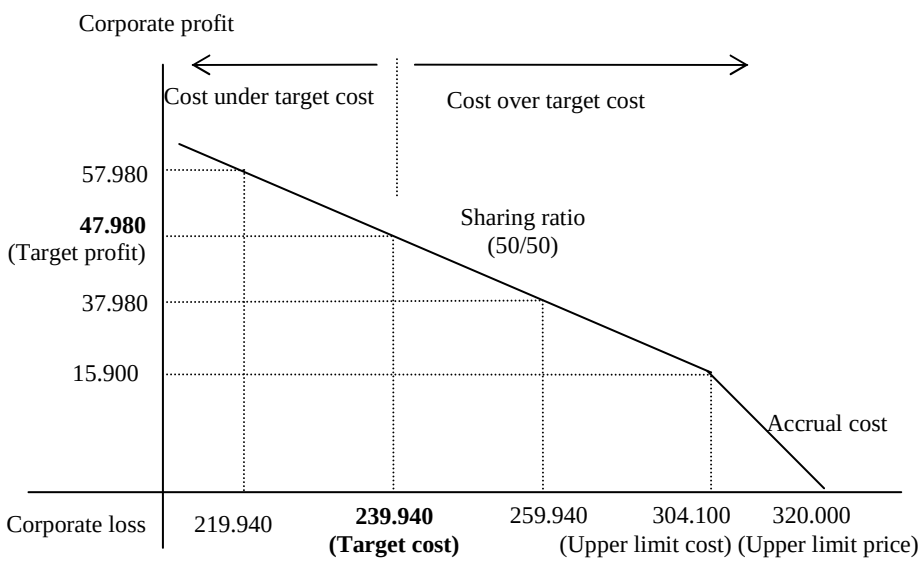

Figure 3. **Relationship between accrued cost and profits,** *authors'*

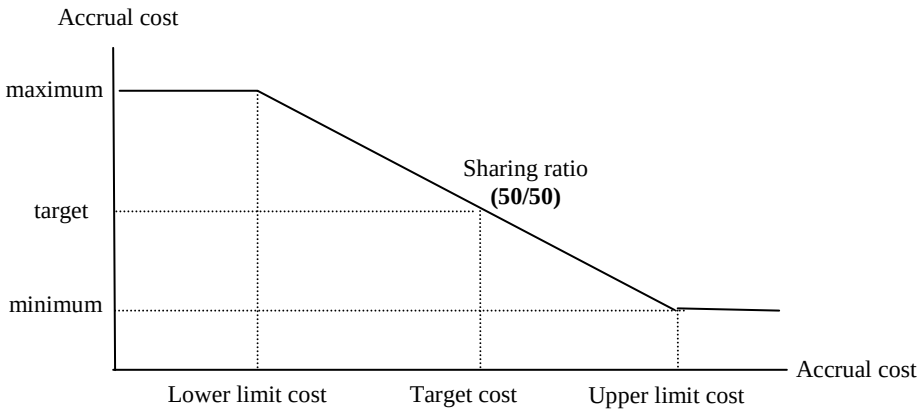

Figure 4. **Cost calculations in the incentive contract based on fees,** *authors'*

A multi-level cost-profit chart. As in incentive fixed price cost accounting, sharing conditions can be set differently by section. For example, to give defense contractors a motivation to work on cost control more actively, the government can set a 95/5 contract for around target cost, 50/50 or 80/20 contracts for certain degrees of cost reducing and cost exceeding situations, respectively. Figure 5 illustrates the situation.

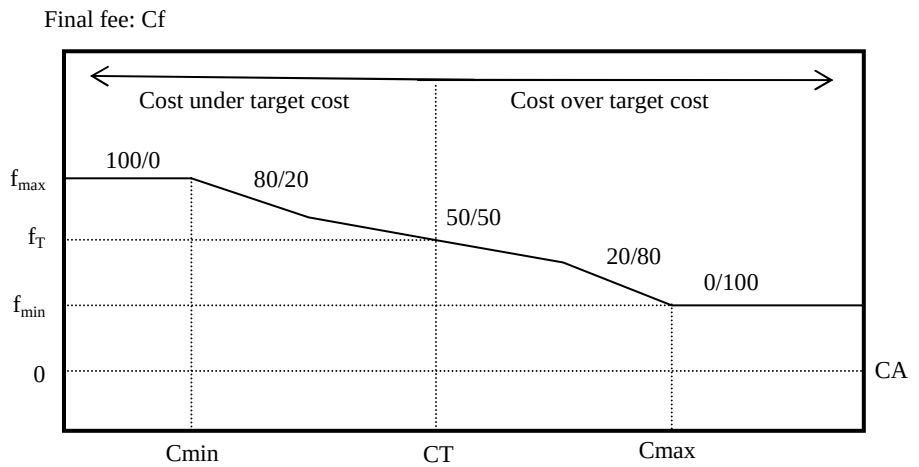

Figure 5. **A multi-level cost-profit chart,** *authors'*

This method is useful when uncertainty for performance and cost is too big for a fixed-price contract but too small for a fixed commission contract. For example, it works well to calculate cost for products at development stage, prototypes, or munitions that are big in size but small in quantity with expensive price per unit because cost proportion is high for expensive products. The method guarantees profits within the maximum and minimum commission levels after separating the actual cost by sections depending on the degrees of excess cost or cost reduction.

Concluding remarks. The problems of current costing system for defense contracts in Korea include the compensation system based on actual cost and over-reliance on direct labor cost. For example, the government assigns only one company for the most of its defense articles, and as a result, about 65% of contracts are private ones and the cost of contract is determined by the actual costs submitted by the contractor. Based on the standard and guidance for calculating the price of defense industry goods, the contractor categorizes cost as direct and indirect materials, direct and indirect labor, and direct and indirect expenses. But unlike accounting standards for business, indirect labor and indirect expenses are determined by ratios calculated based on direct labor.

Other related characteristics of the current costing system includes that DAPA determines all the ratios (indirect labor ratio, indirect expense ratio, general and administrative expense ratio, profit ratio, compensation ratio for the invested capital etc.) and those ratios are applied to calculate the cost of a contract. Finally, defense products are exempted from VAT and it gives tax incentives to defense contractors and helps promote defense industry in general. It is important to understand the type and the characteristics of cost in order to make a variety of cost-related decisions, and to understand cost behavior (how cost behaves when the production level of activity changes within a certain range). Based on cost behavior, cost can be categorized as either variable, or fixed one.

Cost-Volume-Profit (CVP) analysis is a technique to investigate how changes in activity level influence changes in costs and profits. It will be very useful in making decisions such as marketing plans and price settings. The paper has applied the graphical method of CVP analysis as the basic concept to calculate the cost of producing defense products with higher than a certain level of production activity. Specifically, the paper developed and analyzed an objective cost equation model through accounting engineering approach and applied the model to actual cost structure rates in defense contractors in Korea with the focus on indirect processing costs.

The proposed method can predict reasonable costs and thus contributes to establishing trust between government and defense contractors by the application of objective cost function formula (equation model). That is, future predictable cost or target cost can be used practically as a basic cost in medium-term planning and budgeting or determination of the bidding price or contract costs. It will save time and effort in calculating the cost for defense contracts and it also can be used to build a database for standard cost by equipment (or product) and contractors. It is essential to improve trust regarding the cost processes (e.g., developing ratios by cost components) to improve the overall efficiency of national defense operations.

In the future, international defense market would be expanded to a private investment market with a variety of financial and economic theories. For example, if highly expensive defense munitions can be supplied through lease purchase contract, then governments can calculate lease payments based on target cost and it can be used as a reference for price determination in negotiating on technology transfer and exchange. To prepare for the future of defense cost accounting environment, we hope, more research on new methods to calculate the cost for defense contractors will be continued using accounting engineering modeling and simulation, SWOT analysis, brainstorming as well as more advanced techniques.

References:

Abernethy, M.A., Lillis, A. (1995). The Impact of Manufacturing Flexibility on Management Control System. Design. Accounting, Organization and Society, 20(4): 241–258.

Braeutigam, R., Panzar, J.C. (2009). Diversification incentives underprice-based and cost-based regulation. Rand Journal of Economics, 20(3): 373–391.

Choi, K.-I. (2013). Fairness and Transparency as Defense Cost, Based on Development by Defense Industry. Policy Briefing Column, Ministry of Culture, Sports and Tourism.

Cooper, R., Kaplan, R.S. (1992). Activity Based Cost Systems: Measuring the Cost of Resource Usage. Accounting Horizons, 6: 188–200.

DAPA (2013). Yearly Statistics. Annual Report of Defense Industry Statistics, Defense Acquisition Program Administration (DAPA), Seoul, Korea.

Kaplan, R.S., Norton, D.P. (1996). Linking the Balanced Scorecard to Strategy. California Management Review, 39(1): 53–79.

KDIA (2010). Management Analysis for Military Defense Corporate. Korea Defense Industry Association.

Kim, D.S., Gang, N.J. (2008). Basics & Application of Regression Analysis. Nanam.

Kim, D.U., Jeong, H.R. (2012). A study on the cost structure of South Korea Military Defense Industry. National Defense Policy Research, 28(3): 109–143.

Park, W.G., Hwang, H.C. (2011). Technical Accounting. Kyeong Moon Sa.

Porter, M.E. (1985). Competitive Advantage: Creating and Sustaining Superior Performance. The Free Press. New York.

Shank, J.K., Govindarajan, V. (1992). Strategic Cost Management and the Value Chain: the Value Chain perspective. Journal of Cost Management, 5(4): 5–21.

Young, S., Selto, F. (1993). Explaining cross-sectional Workgroup Performance Differences in a JIT Facility: A Critical Appraisal of a Field-Based Study. Journal of Management Accounting Research, 5(Fall): 300–326.

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