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Target Cost Setting Method and Authority of Target Cost Allocation in Product Development Organizations

by

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Abstract

This paper investigates how the causal relationship among product development organizations, methods for setting target costs, and authority in the allocation of target cost affects cost reduction performance, through a questionnaire survey of the Japanese companies listed on the Tokyo Stock Exchange. The authors use a log-linear model to test this relationship. In companies with multi-centered structure of product development, the functional staffs involved in decision-making of target cost allocation with the project leaders could improve the performance of cost reduction activities. It implies that multi-project management could raise members' motivation to encourage in cost reduction activities. As a result, a high cost reduction performance could be achieved under multi-centered structure of product development. The author named it "top-down target costing system". In addition, when the functional staffs involved in decision-making of target cost allocation with the project leaders, companies tend to set target cost by the subtractive method rather than by the hybrid method. In other words, market orientation management made efficiently the teamwork of both the project leader and the functional staffs in decision-making of target cost allocation.

Keywords: *Target costing, Target cost setting method, Matrix structure, multi-centered structure*

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1. Introduction

Target costing is a cost management technique that is well known among Japanese companies. It was developed in Japan, based on the U.S. value engineering (VE) method (Monden, 1994; Ansari *et al.*, 1997; Cooper & Slagmulder, 1997). As one of the main cost management techniques developed to maintain competitiveness, Japanese companies often utilize the target costing system to establish systematic and rational management systems to keep product costs low. Toyota, the well-known automobile company, has applied target costing to produce good-quality, low-priced products successfully. Fundamentally, Toyota's success relies on its efficient product development organization.

Therefore, there must be evidence linking organizational efficiency (Clark & Fujimoto, 1991; Powell, 1992; Kloot, 1997) with the target costing system. The authors examined the relationship between organizational efficiency, especially product development efficiency, and target costing. From the responses to the 1996 "Target Costing Survey" of Japanese companies listed on the Tokyo Stock Exchange, the authors classified product development organizations into two types: matrix structure and multi-centered structure.

There are two essential issues in target costing systems: setting and allocating target costs. In practice, Japanese companies use three methods to set the target cost of a new product: the subtractive, adding-up, and hybrid methods. On the other hand, project leaders or functional staffs have the authority to assign the target cost of a new product. How effectively the target cost so decided is allocated may influence the efficiency of cost reduction activities in different product development organizations.

This study analyzed the cost reduction effects of alternative product development organizations, alternative methods for setting target costs, and alternative decision-making authority in assigning target costs using a log-linear model (Matsuda, 1988; Agresti, 1990), and this survey contained only qualitative answers.

The remainder of this chapter is organized as follows. Section two presents the target costing framework and develops hypotheses. Section three outlines the target costing questionnaire survey. Section four explains the application of the log-linear model and presents the results. Section five discusses the practical implications of these results.

2. Framework and hypotheses

To clarify the relationship between product development organization and target costing systems, it is necessary to mention Toyota's product development structure, since Toyota has successfully developed many new products utilizing target costing.

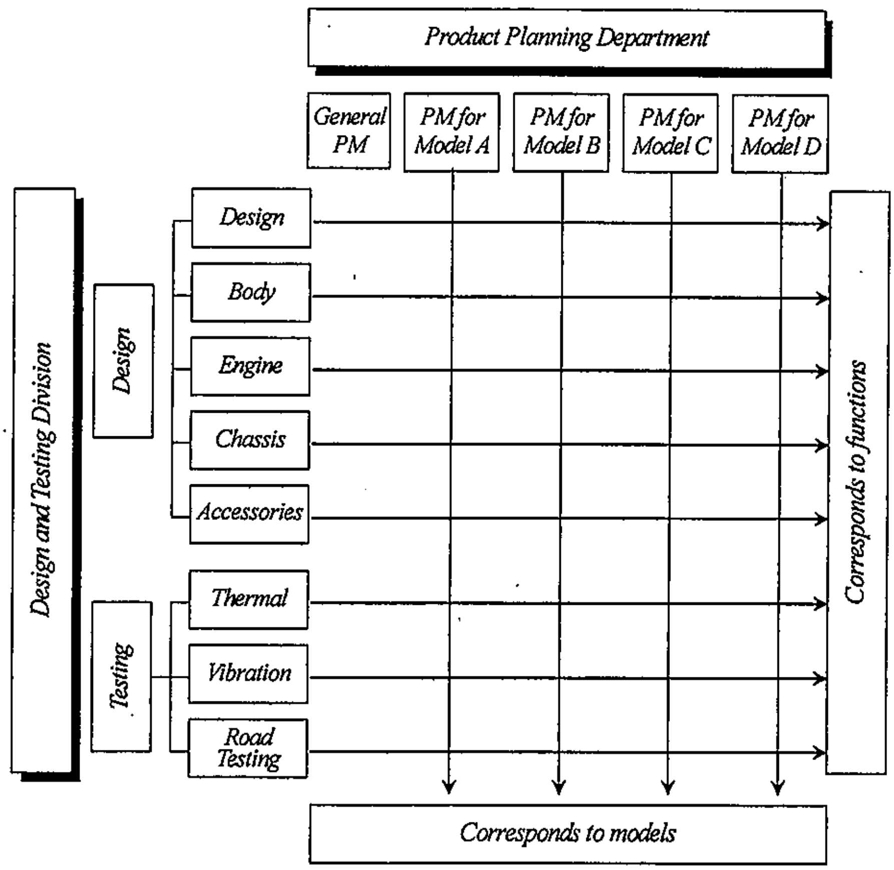
2.1. Product Development Organizations

Toyota first introduced two types of product development organization: matrix structure and multi-centered structure. According to the 1996 target costing survey, these two product development structures have since been adopted by other automobile companies, as well as manufacturing companies.

In a matrix structure product development organization, companies establish separate product project departments and functional design departments to develop new products. Each project department develops new products in coordination with the relevant functional design department. The product project leaders are responsible for conceptualizing the product, drafting the basic product plan, and establishing the product target cost. The functional staffs design the functional parts of the products. The relationships between the two types of department have a matrix structure (Figure 1), under which project leaders assigned to specific models (or products) work with functional staff assigned to specific functions.

Figure 1

Matrix Structure of Product Development



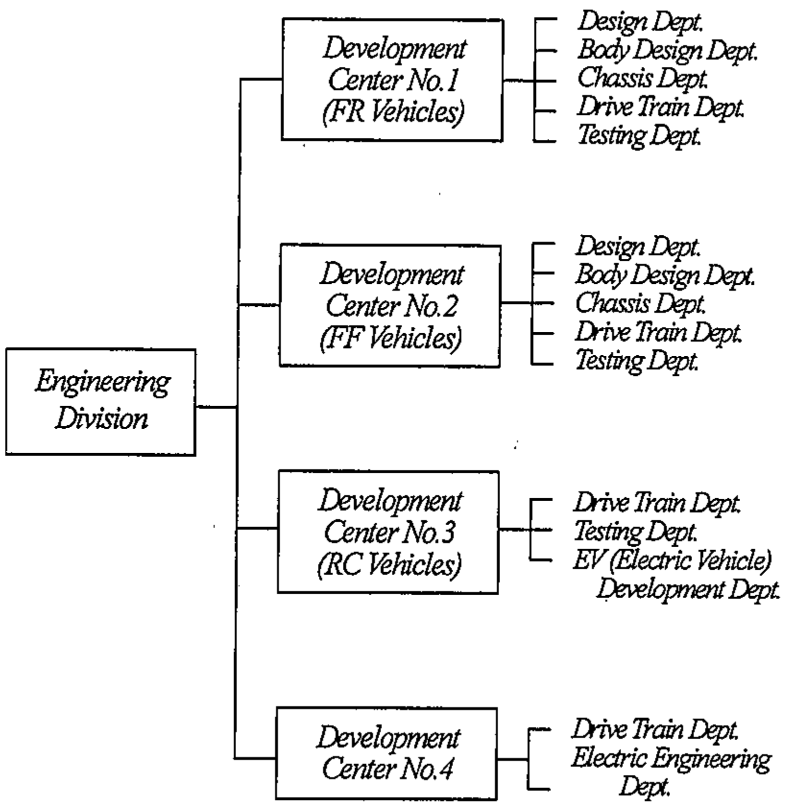
PM: Product Manager

Alternatively, several project centers may be established in a product development organization and each center develops a new product project in coordination with its own functional design group. For automobiles, these functional design groups refer to departments assigned to planning, style, body, interior, chassis, and engine design, and testing. The functional staff at each center work most closely with their product project and report to the center head.

Under the matrix structure of new product development, product project departments and functional design departments are established independently and separately. A project leader is a project department manager who takes responsibility for a new product project, and a functional manager, the leader of a functional design department, manages the functional staff in his or her functional design department. However, the functional staff involved in new product development report to both their project leader and their functional manager.

Figure 2

Multi-centered Structure of Product Development



Source: Monden (1994, 29)

Alternatively, all products are assigned to respective product development centers according to the nature of the products. All projects in a center are developed using a common platform, and each project leader works cooperatively with the staff of the relevant functional design department in the center. Under this multi-centered structure of new product development, functional design departments (or teams) are established in each center (Monden, 1994; Nobeoka, 1996; Cusumano & Nobeoka, 1998). In this paper, we call this the "multi-centered structure of new product development" (Figure 2). Toyota developed this type of organization in 1992. Before 1992, Toyota used the functional matrix structure of new product development (Cusumano & Nobeoka, 1998).

Before 1992, Toyota faced many problems with the functional matrix structure, such as poor communication between project leaders and functional staff, and the decision-making involved in designing and developing products took too long. Moreover, given the great variety of products, managerial obstacles, such as allocating capital and personnel, transforming production technology, and adopting common parts, affected production efficiency and rationalization. To solve these problems and to reinforce market competitiveness, it was necessary to establish a more flexible and less sophisticated product development organization. Therefore, multi-centered structure of product development was adopted (Cusumano & Nobeoka, 1998).

Recently, other automobile companies have adopted multi-centered structures of new product development similar to that at Toyota (Cusumano & Nobeoka, 1998). Moreover, most manufacturing companies have also adopted multi-centered structure of product development. Our questionnaire survey indicated that in 1996, 45% of companies used the matrix structure of product development, while 32% of companies used multi-centered structure of product development. About 22% of companies have adopted other product development organizations. In this study, the authors compared the implementation of target costing systems under the matrix and multi-centered structures.

2.2. Target Cost Setting

There are three methods for setting target costs in Japanese companies. They are the subtractive, hybrid, and adding-up methods (Tanaka, 1989; Kondo, 1990; Shimizu, 1992b; Kanazawa & Monden, 1994; Monden, 1994, 75). Setting the target cost of a new product is the most critical step in a target cost system, since target cost is affected by a company's product strategy and long-term profit plans (Ansari *el at.*, 1997). In addition, 70-90% of all costs are typically incurred during the product development stage, so it is important to set an attainable target cost (Euske & McNair, 1993; Monden, 1994; Koga & Matsuo, 1996; Ansari *el at.*, 1997).

2.2.1. Subtractive Method

In this method, the target cost is calculated by subtracting the target profit from the target sales price. Alternatively, it can be calculated by multiplying (1- target return-on-sales ratio) and target sales price. In this method, the "allowable cost" as measured by the right side of Formula (1) is treated as the target cost. That is,

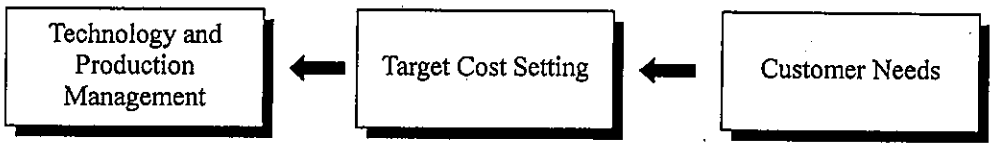
Target cost = target sales price – target operating profit, or (1)

Target cost = target sales price × (1 – target return-on-sales ratio) (2)

This method incorporates a customer-based concept. Given the target sales price and target sales profit, the target cost can be measured. It is important to consider how many products will be on the market, the price of rival products, and how much profit the company wants. A basic concept is "How will a good product that is recognized by customers are developed". Therefore, to meet customer needs and take advantage of product pricing, companies must effectively manage product costs, while considering market pressure (Figure 3) (Kondo, 1990).

Figure 3

Customer-Based Target Cost Setting



In response to market pressure and competitiveness, companies are motivated to improve technology and production management, and to reinforce product innovation. Since the current technology basis is not considered when the target cost is set, the target cost is not easily attained in practice. In other words, the target cost is usually set tightly by this method.

2.2.2. Adding-Up Method

Since the allowable costs are determined by market conditions without considering the design capability or production technology of the company, the requirements for cost reduction are very severe and not easily achieved (Monden & Hamada, 1991). For a company whose allowable costs are not usually achievable, the "drifting cost" is considered. The drifting cost involves calculating the cost of a part without considering cost reduction targets. Determining the target cost in this way is called the "adding-up method" or the "estimated cost-based method." The drifting cost is also called the estimated cost.

The target cost is calculated by subtracting the per-unit profit improvement target value from the estimated cost based on the present technology used by the company, so it is necessary to know the current production technology used by the company (See formula 3). The estimated cost of a product is measured by summing the estimated costs of each part.

Target cost = Σ estimated cost i – profit improvement target value, (3)

Where, profit improvement target = estimated profit – target profit.

This is the traditional method; given a target cost and a target sales profit, the target sale price can be decided. Companies usually think that a good product that is recognized by customers will sell well, so it is essential to produce a good product. Developing a good product requires improved production technology, to make it possible to develop a good-quality, low-priced product.

Therefore,. the adding-up method is a technology-based concept (Figure 4). Companies set the target cost while considering their current production technology and management system, and produce a product that has good cost performance and good quality corresponding to customer needs (Kondo, 1990).

Figure 4

Technology-Based Target Cost Setting

Technology and Production Management → Target Cost Setting → Customer Needs

2.2.3. Hybrid (or Combination) Method

The target cost is determined by considering both the allowable cost and the drifting cost, so that the target cost is intermediate between the other two estimates. The complete calculation is as follows:

$$\text{Target cost} = w_1 S + w_2 A \qquad (4)$$

$$w_1 + w_2 = 1,$$

Where, S = Target cost by subtractive method,

A = Target cost by Adding-up method

Adopting these methods, the target cost can be set effectively and efficiently. These methods need not be applied in every company, since a company tends to apply one method to set the target cost of a product given its specific manufacturing background, such as product development organization, organizational setting, and manufacturing conditions.

In the next section, we examine how Japanese companies apply these target cost setting methods in their product development organizations.

2.3. Setting and Allocating Target Cost with Multi-Centered Structure

In practice, small firms usually adopt the functional matrix structure. Under the matrix structure, each functional staff usually supports 3 or 4 product projects to maintain the efficiency of product development (Cusumano & Nobeoka, 1998). Companies can utilize all their functional design departments to develop a number of product projects, so there is the advantage of economy of scale in information processing and technology sharing via the pools of functional staff assigned to the functional design departments. Due to managerial resource sharing, product development is accomplished by a few experts in the functional design departments (Davis & Lawrence, 1977; Shibata & Nakahashi, 1997). If the product projects are very different, the functional staff might not run all the product development projects efficiently. Simultaneous project management also makes it quite difficult for project leaders to cooperate with the functional staff.

With a multi-centered structure for product development, each center is determined by the attributes of product projects. First, the center develops similar products on a common platform and the project leaders coordinate with the functional design teams that are independently allocated to each center. Second, each project leader is responsible for one product project and the relevant functional staff report to the project leader. Third, the project leaders are empowered by top management under multi-centered structure of product development. This empowerment facilitates achieving strategic product management and cost reduction.

For successful new product development and good performance, the project leaders may set a tight cost target by referring to the prices of rival or similar products. Given the target sales price and the target sales profit, the target cost can be determined by the subtractive method. This method usually sets a tighter target cost than other methods. Since the target sales price is market-driven and project leaders usually fix the target sales profit to achieve good cost performance, no compromise in the cost target is required under the subtractive method.

The roles of the project leaders are very clear in the multi-centered structure. They initiate new product development projects in coordination with the relevant functional design departments. They engage in cost reduction activities with the functional staff in order to achieve good quality and low price. To achieve smooth cost reduction, each project leader must establish a cost budget for individual products (Monden, 1995, 155). Cost budget management includes setting the cost target level and breaking down component costs. Therefore,

H1: Under the multi-centered structure of product development, companies tend to set the target cost by the subtractive method.

Multi-centered structure also has merits when it comes to sharing personnel resources and technology among projects. The project leaders can exchange knowledge and experience among projects to improve product development efficiency and the creativity of the functional staff. Knowledge dynamics, the exchange of knowledge among teams and interactions among staff result in dynamic communication, which increases inter-departmental coordination and communication (Cusumoto, Nonaka & Nakata, 1995). The interaction between the project leaders and the functional staff and the interaction of knowledge dynamics in product quality can reduce costs (Cusumoto, Nonaka & Nakada, 1995; Kono & Nonaka, 1995; Madhavan & Grover, 1998).

Under these conditions, the authors think that project leaders may take the initiative in product development in setting product cost targets and allocating the breakdown of component costs. The sharing of personnel and technology among projects allows the cost reduction activities to be implemented effectively and efficiently. Consequently, good cost performance in developing a new product is achieved.

When leaders in each center allocate component target costs, target costing and cost reduction activities may be facilitated, because the leaders in each center are responsible for maintaining personnel relationships within the organization, and motivating their staff to achieve the organizational goals (House, 1971; Steers, 1975; Isabella & Waddock, 1994; Durham *et al.*, 1997). On the other hand, the functional staffs have expertise in functional design, so they are very familiar with current production technology, and understand production equipment operation, expected costs, and the lead time required to develop products. Moreover, under the matrix structure of product development, they should be empowered to allocate target costs by motivating the functional staff to reduce costs. By doing so, the functional staffs are involved in 'organizational participation' (Glew *et al.*, 1995). Good cost performance accompanies the organizational participation of functional staff (Ronen, 1974; Monden *et al.*, 1997). Since the functional staffs are directly involved in allocating target costs, they must carry out the cost reduction activities. This is a concrete goal for cost reduction, so it is easy to achieve (House, 1971; Latham & Yukl, 1975; Indjejikian & Nanda, 1991; Hoque, Akter & Monden, 2000). The participation of the functional staff in decision-making can help meet organizational goals and increase personal satisfaction.

Consequently, the authors developed the following hypothesis:

H2: Under the multi-centered structure of product development, the decision of the target cost allocation tends to be made by the project leaders or both the project leaders and the functional staffs for a good cost reduction performance.

3. Target costing survey

The Tokyo Stock Exchange lists 518 companies that produce four types of products: machinery, electronics equipment, transportation equipment, and precision instruments. These were surveyed, since target costing has been adopted in these industries (Tani *et al.*, 1994; Nishizawa, 1995). The survey examined authority and decision-making in adopting target costing systems. The survey contained 43 questions in 11 sections. The sections were "condition of the company", "organization of target costing", "methods for setting target sales price", "methods for setting target sales profit", "methods for setting target cost", "allocating, achieving, and following-up target cost", "VE activities in product design", "utilization of cost tables", "stage of product preparation", "suppliers' relationship", and "environmental uncertainty and complexity". The survey was mailed to the project leaders directly involved in target costing in each company on Oct. 10, 1996, with Nov. 10, 1996 as the deadline for return. The response rates in the four industries are listed in Table 1.

Table 1
Collection rate in 4 types of industry

Type	*Numbers for mailed*	*Numbers for received*	*Collection Rate*	*True collection rate*
Machinery	194	49	25.26%	24.74%
Electrics	198	49	24.74%	24.24%
Transportation	90	38	42.22%	41.11%
Precision	36	10	27.78%	27.78%
Total	518	146	28.19%	27.61%

In this paper, the authors examine four of the survey questions: target cost performance (Q20), product development organization (Q10), positions with decision-making authority to allocate target cost (Q11), and methods for setting target cost (Q18) (Appendix). The authors analyze the relationships between them.

4. Statistical analysis

A 4-way contingency table for the four above-mentioned factors (variables) containing 54 cells was considered (Table 2). Considering the distribution of the data and the simplicity of the loglinear models, the four variables are named *Org*, *All*, *Set*, and *Per*, and the categories corresponding to the respective variables were *i*, *j*, *k*, and *l* ($i = 1, 2; j = 1, 2, 3; k = 1, 2, 3; l = 1, 2, 3$). The expected frequencies for cells were f_{ijkl}, and the observed frequencies were g_{ijkl}.

The log-linear model includes the intercept, all main effect terms, and interaction terms. The formula is as follows:

$$\begin{aligned}\log f_{ijkl} &= \lambda + \lambda_i^{Org} + \lambda_j^{All} + \lambda_k^{Set} + \lambda_l^{Per} + \lambda_{ij}^{Org\cdot All} + \lambda_{ik}^{Org\cdot Set} + \lambda_{il}^{Org\cdot Per} \\ &+ \lambda_{jk}^{All\cdot Set} + \lambda_{jl}^{All\cdot Per} + \lambda_{kl}^{Set\cdot Per} + \lambda_{ijk}^{Org\cdot All\cdot Set} + \lambda_{ijl}^{Org\cdot All\cdot Per} + \lambda_{ikl}^{Org\cdot Set\cdot Per} \\ &+ \lambda_{jkl}^{All\cdot Set\cdot Per} + \lambda_{ijkl}^{Org\cdot All\cdot Set\cdot Per} \\ &(i = 1,\ldots, 2;\; j = 1,\ldots, 3;\; k = 1,\ldots, 3;\; l = 1,\ldots, 3)\end{aligned} \quad (7)$$

The parameters λ_i^{Org}, λ_k^{All}, λ_j^{Set} and λ_l^{Per} are the main effect terms for the variables *Org*, *All*,*Set*, and *Per*, respectively. The parameters $\lambda_{ik}^{Org\cdot Set}$, $\lambda_{ij}^{Org\cdot All}$, $\lambda_{il}^{Org\cdot Per}$, $\lambda_{jk}^{All\cdot Set}$, $\lambda_{kl}^{Set\cdot Per}$, $\lambda_{jl}^{All\cdot Per}$, $\lambda_{ijk}^{Org\cdot All\cdot Set}$, $\lambda_{ikl}^{Org\cdot Set\cdot Per}$, $\lambda_{ijl}^{Org\cdot All\cdot Per}$, $\lambda_{jkl}^{All\cdot Set\cdot Per}$, $\lambda_{ijkl}^{Org\cdot All\cdot Set\cdot Per}$ are the interaction terms that reflect the inter-dependence of *Org-Set*, *Org-All*, *Org-Per*, *All-Set*, *Set-Per*, *All-Per*, *Org-All-Set*, *Org-Set-Per*, *Org-All-Per*, *All-Set-Per*, and *Org-All-Set-Per*, respectively. The log-linear model has a structure similar to models in a 4-way factorial ANOVA. The terms with a single subscript are similar to the main effects, and those with a double subscript are similar to 2-factor interactions.

Table 2

Categories of Factors of *Org*, *All*, *Set*, and *Per*

Factor	*Item*	*Category*	*Content*
Org	Product development organization (Q10)	i=1	Matrix structure (Answer 1)
		2	Multi-centered structure (Answer 2)
All	Authority to allocate target cost (Q11)	j=1	It is allocated by project leaders (Answers 1 and 2)
		2	It is allocated by project leaders and functional staff (Answer 3)
		3	It is allocated by functional staff (Answers 4 and 5)
Set	Method used to set target cost (Q18)	k=1	Subtractive method (Answer 1)
		2	Hybrid method (Answer 2)
		3	Adding-up method (Answer 3)
Per	Cost reduction performance (Q20)	l=1	79% or less (Answers 1 and 2)
		2	80% ~ 89% (Answer 3)
		3	90% or more (Answers 4 and 5)

First, all parameters are defined as follows:

$$\mu = \log f_{i\bullet j\bullet k\bullet l\bullet}$$

$$\begin{aligned}
&\lambda_i^{Org} = \log f_{ij\bullet k\bullet l\bullet} - \mu, \quad \lambda_j^{All} = \log f_{i\bullet jk\bullet l\bullet} - \mu, \\
&\lambda_k^{Set} = \log f_{i\bullet j\bullet kl\bullet} - \mu, \quad \lambda_l^{Per} = \log f_{i\bullet j\bullet k\bullet l} - \mu, \\
&\lambda_{ijk}^{Org\cdot All\cdot Set} = \log f_{ijkl\bullet} - (\lambda_{ij}^{Org\cdot All} + \lambda_{ik}^{Org\cdot Set} + \lambda_{il}^{Org\cdot Per}) - \mu, \\
&\lambda_{ijl}^{Org\cdot All\cdot Per} = \log f_{ijk\bullet l} - (\lambda_{ij}^{Org\cdot All} + \lambda_{il}^{Org\cdot Per} + \lambda_{jl}^{All\cdot Per}) - \mu, \\
&\lambda_{ikl}^{Org\cdot Set\cdot Per} = \log f_{ij\bullet kl} - (\lambda_{ik}^{Org\cdot Set} + \lambda_{il}^{Org\cdot Per} + \lambda_{kl}^{Set\cdot Per}) - \mu, \\
&\lambda_{jkl}^{All\cdot Set\cdot Per} = \log f_{i\bullet jkl} - (\lambda_{jk}^{All\cdot Set} + \lambda_{jl}^{All\cdot Per} + \lambda_{kl}^{Set\cdot Per}) - \mu, \\
&\lambda_{ijkl}^{Org\cdot All\cdot Set\cdot Per} = \log f_{ijkl} - (\lambda_{ijk}^{Org\cdot All\cdot Set} + \lambda_{ijl}^{Org\cdot All\cdot Per} + \lambda_{ikl}^{Org\cdot Set\cdot Per} + \lambda_{jkl}^{All\cdot Set\cdot Per}) \\
&\qquad - (\lambda_{ij}^{Org\cdot All} + \lambda_{ik}^{Org\cdot Set} + \lambda_{il}^{Org\cdot Per} + \lambda_{jk}^{All\cdot Set} + \lambda_{jl}^{All\cdot Per} + \lambda_{kl}^{Set\cdot Per}) \\
&\qquad - (\lambda_i^{Org} + \lambda_j^{All} + \lambda_k^{Set} + \lambda_l^{Per}) - \mu,
\end{aligned} \tag{8}$$

Table 3

Saturated Model for Factors of *Org*, *All*, *Set*, and *Per*

Parameter	Coefficient	Asymptotic t-value	Parameter	Coefficient	Asymptotic t-value
λ_2^{Org}	-0.035	-0.141	$\lambda_{222}^{Org\cdot All\cdot Set}$	**0.788**	**1.000**
λ_2^{All}	-0.152	-0.552	$\lambda_{223}^{Org\cdot All\cdot Set}$	0.449	0.571
λ_3^{All}	**-0.645**	**-2.029**	$\lambda_{232}^{Org\cdot All\cdot Set}$	0.281	0.327
λ_2^{Set}	**0.668**	**2.120**	$\lambda_{233}^{Org\cdot All\cdot Set}$	0.159	0.202
λ_3^{Set}	**0.415**	**1.273**	$\lambda_{222}^{Org\cdot All\cdot Per}$	-0.791	-0.589
λ_2^{Per}	**0.498**	**1.493**	$\lambda_{223}^{Org\cdot All\cdot Per}$	**-1.515**	**-1.051**
λ_3^{Per}	**0.881**	**2.835**	$\lambda_{232}^{Org\cdot All\cdot Per}$	-1.072	-0.639
$\lambda_{22}^{Org\cdot All}$	-0.036	-0.065	$\lambda_{233}^{Org\cdot All\cdot Per}$	-0.050	-0.030
$\lambda_{23}^{Org\cdot All}$	0.274	0.430	$\lambda_{222}^{All\cdot Set\cdot Per}$	**2.650**	**1.750**
$\lambda_{22}^{Org\cdot Set}$	0.002	0.002	$\lambda_{223}^{All\cdot Set\cdot Per}$	**1.559**	**1.212**
$\lambda_{23}^{Org\cdot Set}$	-0.641	-0.984	$\lambda_{232}^{All\cdot Set\cdot Per}$	**2.396**	**1.429**
$\lambda_{22}^{Org\cdot Per}$	-0.601	-0.902	$\lambda_{233}^{All\cdot Set\cdot Per}$	0.547	0.332
$\lambda_{23}^{Org\cdot Per}$	-0.577	-0.929	$\lambda_{322}^{All\cdot Set\cdot Per}$	-0.055	-0.033
$\lambda_{22}^{All\cdot Set}$	-0.054	-0.081	$\lambda_{323}^{All\cdot Set\cdot Per}$	-0.450	-0.286
$\lambda_{23}^{All\cdot Set}$	**-0.989**	**-1.374**	$\lambda_{332}^{All\cdot Set\cdot Per}$	-0.903	-0.525
$\lambda_{32}^{All\cdot Set}$	0.536	0.639	$\lambda_{333}^{All\cdot Set\cdot Per}$	-0.435	-0.276
$\lambda_{33}^{All\cdot Set}$	0.109	0.133	$\lambda_{2222}^{Org\cdot All\cdot Set\cdot Per}$	-0.213	-0.114
$\lambda_{22}^{All\cdot Per}$	-0.676	-0.893	$\lambda_{2223}^{Org\cdot All\cdot Set\cdot Per}$	-0.718	-0.461
$\lambda_{23}^{All\cdot Per}$	-0.329	-0.512	$\lambda_{2232}^{Org\cdot All\cdot Set\cdot Per}$	1.103	0.553
$\lambda_{32}^{All\cdot Per}$	0.353	0.421	$\lambda_{2233}^{Org\cdot All\cdot Set\cdot Per}$	-0.010	-0.005
$\lambda_{33}^{All\cdot Per}$	-0.131	-0.160	$\lambda_{2322}^{Org\cdot All\cdot Set\cdot Per}$	0.553	0.251
$\lambda_{22}^{Set\cdot Per}$	-0.035	-0.141	$\lambda_{2323}^{Org\cdot All\cdot Set\cdot Per}$	1.822	0.834
$\lambda_{23}^{Set\cdot Per}$	-0.152	-0.552	$\lambda_{2332}^{Org\cdot All\cdot Set\cdot Per}$	0.130	0.061
$\lambda_{32}^{Set\cdot Per}$	**-0.645**	**-2.029**	$\lambda_{2333}^{Org\cdot All\cdot Set\cdot Per}$	0.963	0.471
$\lambda_{33}^{Set\cdot Per}$	**0.668**	**2.120**			

The other parameters are defined similarly. All parameters estimated are shown in Table 3. Wedderburn (1974) introduced the quasi-likelihood estimation to estimate the dispersion parameters ϕ.

$$\phi = X^2/(N-df),\ \text{where}\ X^2 = \sum_2\sum_3\sum_3\sum_3 (g_{ijkl} - f_{ijkl})^2 / f_{ijkl}$$

N: The number of cell

df: Degree of freedom

We assure the efficiency of coefficients between variance and mean by using the dispersion parameters ϕ, so that

Asymptotic t-value = Coefficient / $\sqrt{\phi}$

The asymptotic t-values of the parameters of { λ_3^{All} }, { λ_2^{Set} }, { λ_3^{Per} }, { $\lambda_{32}^{Set\cdot Per}$ }, and { $\lambda_{33}^{Set\cdot Per}$ } are over ± 2; and the asymptotic t-values of the parameters of { λ_3^{Set} }, { λ_2^{Per} }, { $\lambda_{23}^{All\cdot Set}$ }, { $\lambda_{222}^{Org\cdot All\cdot Set}$ }, { $\lambda_{223}^{Org\cdot All\cdot Per}$ }, { $\lambda_{222}^{All\cdot Set\cdot Per}$ }, { $\lambda_{223}^{All\cdot Set\cdot Per}$ }, and { $\lambda_{232}^{All\cdot Set\cdot Per}$ } are over ± 1. Obtaining the best and simple model, the author made some unsaturated models by considering the parameters that the asymptotic t-values are over ± 1.

Under the unsaturated model, certain parameters are set to zero in formula (7), and then certain higher-order parameters are treated as zero according to hierarchical principles. For instance, if $\lambda_{kl}^{Set\cdot Per} = 0$, then $\lambda_{ikl}^{Org\cdot Set\cdot Per} = \lambda_{jkl}^{All\cdot Set\cdot Per} = \lambda_{ijkl}^{Org\cdot All\cdot Set\cdot Per} = 0$. Therefore, the log-linear model in the case is as follows:

$$\log f_{ijkl} = \lambda + \lambda_i^{org} + \lambda_j^{All} + \lambda_k^{Set} + \lambda_l^{Per} + \lambda_{ij}^{Org\cdot All} + \lambda_{ik}^{Org\cdot Set} + \lambda_{il}^{Org\cdot Per} + \lambda_{jk}^{All\cdot Set} + \lambda_{kl}^{All\cdot Per} + \lambda_{ijk}^{Org\cdot All\cdot Set} + \lambda_{ijl}^{Org\cdot All\cdot Per} \qquad (9)$$

This is a hierarchical model. For simplicity, this model is assigned a symbol that lists the highest-order effects as *Org-All-Set* / *Org-All-Per*. This symbol is the definition set of the log-linear model of formula (9). To precisely estimate parameters and cell probabilities in the log-linear model, model fitting is needed. The authors used partial chi-squared statistics to test the hypothesis that the expected frequencies f_{ijkl} for a given model fit the observed frequencies g_{ijkl}, and used likelihood ratio statistics and the Akaike Information Criterion (*AIC*) to measure the goodness of fit of a specific model. *AIC* is a method for measuring the goodness of fit of a model. To apply the loglinear model, the model selection is extremely critical. We should select an appropriate model by *AIC*. The *AIC* (Akaike information criterion), a basis of comparison and selection among several models, was introduced by Akaike (Akaike 1976, 1979; Sakamoto, Ishiguro, and Kitagawa 1986). There is a tendency, when we choose the model with the largest maximum log likelihood, to choose the model with an unnecessarily large number of free parameters. It is necessary to measure an asymptotically unbiased estimator of the mean expected log likelihood for avoiding this bias as follows (Sakamoto, Ishiguro, and Kitagawa 1986).

(Maximum log likelihood of model) – (number of free parameters of the model)

This value should be minus twice as the criterion for model selection. A model that minimizes the *AIC* is considered to be the most appropriate model.

$AIC = -2 \times$ (maximum log likelihood of the model)

$$+2 \times \text{(number of free parameters of the model)} \tag{10}$$

According to the principle of parsimony, we should choose the model with the smallest number of free parameters when there are several models with similar maximum likelihood values. To compare the goodness of fit between the saturated and hierarchical models easily, the difference between the two models can be calculated as follows (Matsuda, 1988):

$$AIC' = AIC_H - AIC_S = G^2 - 2df \tag{11}$$

Where, AIC_H = AIC of the hierarchical model; AIC_S = AIC of the saturated model; and df = Degrees of freedom

Similarly, under the principle of parsimony, the model with the smallest AIC' should be chosen. The likelihood ratio statistic of the model {*Org-All-Per / All-Set*} is statistically significant at the 0.875 level and the AIC' value of this model is smallest, so this model is selected (Table 4). Therefore, the hierarchical model is as follows:

$$\log f_{ijkl} = \lambda + \lambda_i^{Org} + \lambda_j^{All} + \lambda_k^{Set} + \lambda_l^{Per} + \lambda_{ij}^{Org\cdot All} + \lambda_{il}^{Org\cdot Per} + \lambda_{jk}^{All\cdot Set} + \lambda_{jl}^{All\cdot Per} + \lambda_{ijl}^{Org\cdot All\cdot Per} \tag{12}$$

Table 4

Goodness-of-Fit Tests for Loglinear Models Relating Factors of *Org*, *All*, *Set*, and *Per*

Model	*Set of the hierarchical model*	*df*	G^2 (p-value)	*AIC'*
Model 1.	*Org-All-Set / Org-All-Per / All-Set-Per*	12	5.882(0.922)	-18.118
Model 2	*Org-All-Per / All-Set-Per / Org-Set*	16	9.223(0.904)	-22.774
Model 3	*Org-All-Set / All-Set-Per*	18	16.611(0.550)	-19.389
Model 4	*Org-All-Per / Org-Set / All-Set / Set-Per*	24	17.822(0.812)	-30.180
Model 5	*Org-All-Set / Org-All-Per*	24	14.579(0.932)	-33.421
Model 6	*All-Set-Per / Org*	26	24.010(0.575)	-27.990
Model 7	*Org-All-Per / Org-Set / All-Set*	28	18.933(0.900)	-37.067
Model 8	***Org-All-Per / All-Set***	**30**	**21.411(0.875)**	**-38.589 ***
Model 9	*Org-All-Per / Set-Per*	30	28.980(0.519)	-31.102
Model 10	*Org-All-Set / Set-Per*	30	27.303(0.607)	-32.697

First of all, I set the expected frequency f_{1131} for cell (Org_1 , All_1 , Set_3 , Per_1) be a criterion to estimate the other parameters. According to the alternative constraints, the parameters satisfy the following constraints:

$$\lambda_1^{Org} = \lambda_1^{All} = \lambda_3^{Set} = \lambda_1^{Per} = 0$$

$$\lambda_{1j}^{Org\cdot All} = \lambda_{i1}^{Org\cdot All} = \lambda_{1l}^{Org\cdot Per} = \lambda_{i1}^{Org\cdot Per} = \lambda_{1l}^{All\cdot Per} = \lambda_{j1}^{All\cdot Per} = \lambda_{1k}^{All\cdot Set} = \lambda_{j3}^{All\cdot Set} = 0,$$

$$\lambda_{1jl}^{Org\cdot All\cdot Per} = \lambda_{i1l}^{Org\cdot All\cdot Per} = \lambda_{ij1}^{Org\cdot All\cdot Per} = 0.$$

$$i = 1, 2; \quad j = 1,\cdots,3; \quad k = 1,\cdots,3; \quad l = 1,\cdots,3$$

Table 5

Parameter Estimation for Model $\{Org\text{-}All\text{-}Per\,/\,All\text{-}Set\}$

$$\log f_{ijkl} : \log f_{1131} = \lambda + \lambda_i^{Org} + \lambda_j^{All} + \lambda_k^{Set} + \lambda_l^{Per} + \lambda_{ij}^{Org\cdot All} + \lambda_{il}^{Org\cdot Per} + \lambda_{jk}^{All\cdot Set} + \lambda_{jl}^{All\cdot Per} + \lambda_{ijl}^{Org\cdot All\cdot Per}$$

$i = 2;\quad j = 2, 3;\quad k = 1, 2;\quad l = 2, 3$

λ_i^{Org}		$i=2$	
		-0.830	
		(-0.817)	
λ_k^{All}		$j=2$	$j=3$
		-0.729	-7.649
		(-0.617)	(-0.315)
λ_j^{Set}		$k=1$	$k=2$
		-0.754	-0.194
		(-1.758)	(-0.538)
λ_l^{Per}		$l=2$	$l=3$
		2.398**	2.398**
		(2.296)	(2.296)
$\lambda_{ij}^{Org\cdot All}$		$j=2$	$j=3$
	$i=2$	-1.897	5.771
		(-1.421)	(0.237)
$\lambda_{il}^{Org\cdot Per}$		$l=2$	$l=3$
	$i=2$	-2.909**	-1.928*
		(-2.282)	(-1.620)
$\lambda_{jl}^{All\cdot Per}$		$l=2$	$l=3$
	$j=2$	-2.398**	-1.705
		(-1.901)	(-1.408)
	$j=3$	6.081	6.774
		(0.250)	(0.279)
$\lambda_{jk}^{All\cdot Set}$		$k=1$	$k=2$
	$j=2$	1.110*	0.887†
		(1.700)	(1.512)
	$j=3$	-1.038	0.800
		(-0.893)	(1.285)
$\lambda_{ijl}^{Org\cdot All\cdot Per}$		$l=2$	$l=3$
	$i=2$ $j=2$	3.196**	2.216†
		(1.943)	(1.477)
	$j=3$	-3.961	-6.146
		(-0.163)	(-0.250)

( ): Asymptotic t-value

** $p<0.01$, * $p<0.05$, † $p<0.1$

The parameters estimated in Table 5 have been examined the efficiency of dispersion by dispersion parameter estimation. The model $\{Org\text{-}All\text{-}Per\,/\,All\text{-}Set\}$ (formula 12) whereby *Org-All-Per* and *All-Set* are conditionally independent and the parameters $\{\lambda_{ijl}^{Org\cdot All\cdot Per}\}$ and $\{\lambda_{jk}^{All\cdot Set}\}$ pertain to *Org-All-Per* and *All-Set* partial associations.

As shown in Table 4, the parameters of $\{\lambda_{222}^{Org\cdot All\cdot Per}\}$ and $\{\lambda_{223}^{Org\cdot All\cdot Per}\}$ are positive ($\lambda_{222}^{Org\cdot All\cdot Per}$=3.196 (Asymptotic t-value= 1.943); $\lambda_{223}^{Org\cdot All\cdot Per}$=2.216 (Asymptotic t-value= 1.477)).

The product leader and the functional staffs get together on decision-making of target cost allocation reflected a significant positive relationship with cost reduction performance under multi-centered structure of product development. It implies that if the functional staffs involved in decision-making of target cost allocation with the product leader under the multi-centered structure, high cost reduction performance could be achieved effectively. This result provides limited evidence for H2.

According to model selection (Table 4), there is no direct evidence to explain the relationship between product development structure (*Org*) and target cost setting method (*Set*), so H1 will be not be supported by the model {*Org-All-Per / All-Set*}. However, there is an important relationship between decision-making of target cost allocation (*All*) and target cost setting method (*Set*) in this model. As shown in Table 4, the parameters of $\{\lambda_{21}^{All\cdot Set}\}$ and $\{\lambda_{22}^{All\cdot Set}\}$ are significantly positive ($\lambda_{21}^{All\cdot Set}$=1.110 (Asymptotic t-value=1.700); $\lambda_{22}^{All\cdot Set}$=0.887 (Asymptotic t-value= 1.512)). It indicates that the product managers and the functional staffs involved simultaneously in allocation of target cost set by the subtractive method rather than by the hybrid method. It implies that companies tend to integrate the decision-making of target cost allocation into market orientation policies.

5. Conclusions

The authors conclude that there is a causal relationship among product development organizations, the decision authority in allocating target cost, and target cost reduction performance. Moreover, there is a dependent relationship between target cost setting method (*Set*) and decision-making of target cost allocation (*All*).

In companies with multi-centered structure of product development, the functional staffs involved in decision-making of target cost allocation with the project leaders could improve the performance of cost reduction activities. It implies that multi-project management could raise members' motivation to encourage in cost reduction activities. As a result, a high cost reduction performance could be achieved under multi-centered structure of product development. The author named it "top-down target costing system".

Theoretically, target costing setting is critically connected with target costing system. In this research, it could not find some direct evidence to reflect a positive relationship with cost reduction performance, but the author found target cost setting is related to decision-making of target cost allocation. The author found that when the functional staffs involved in decision-making of target cost allocation with the project leaders, companies tend to set target cost by the subtractive method rather than by the hybrid method. In other words, market orientation management made efficiently the teamwork of both the project leader and the functional staffs in decision-making of target cost allocation.

In this research, the author found that organizational efficiency is connected with cost reduction performance. However, the evaluations of members' performance or the personnel allocation in multi-centered structure may reflect organizational efficiency and performance of cost reduction activities.

Appendix: The survey of target costing

Q10 How is the product development department and the design departments established in your company?

1 The product development departments and the design departments are established independently, separately.

2 It is established the product development centers by products, and the design departments are established in product development centers by the functional parts that the design departments design.

3 Others.

Q11 In deciding to allocate the target cost of functional parts or components, is it allocated by product project managers or the design staffs?

1 It is allocated by the product project managers.

2 Between in '1' and '3'

3 It is allocated by both the product project managers and the design staffs.

4 Between in '3' and '5'

5 It is delegated to the design staffs.

Q18 What is the method to be utilized for setting target cost in your company?

1 The target cost is set by subtracting the target profit from target sales price.(Subtractive method)

2 The target cost is set by comparing the "allowable cost" with the "drifting cost (estimated cost)" whichever is the lowest. The lowest estimated cost will be used to set the target cost. (Hybrid method)

3 The target cost is set by subtracting the per unit profit improvement target value from the estimated cost which can be achieved by the present technology of your company. (Adding-up method)

Q20 How much is the cost reduction performance in your company?

1 60% level or less

2 70% level

3 80% level

4 90% level

5 100% level or more

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