

產品組合決策結合作業基礎成本制度 以提昇企業獲利之研究—以台灣通訊 設備公司為例

Product-Mix Decision Integrated with ABC for Better Profitability Management: The Case of Communications Equipment Firm in Taiwan

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摘要：過去關於產品組合決策的研究，主要分為兩大類，一類為針對不同的成本制度進行比較，另一類則是採用電腦模擬或數學模型推导出最適產品組合決策。然而，產品組合決策建構過程的思考邏輯比最終架構更具關鍵性，因為思考及評估過程中的完整性決定最終架構的適用性。又因為投標市場中，投標廠商可能有多種不同成本的產品同時符合投標規格需求，且每一個標案都對投標公司的損益有重大影響性，因此在電信投標市場中適宜的訂價及產品組合決策更是重要。故本研究選擇以一家通訊設備廠商為個案公司，深入探討該公司如何在電信投標市場中藉由導入作業基礎成本制度（ABC）與改革產品組合決策，來提昇公司的獲利。

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個案公司改革後的產品組合決策係以市場導向策略規劃方式為出發點，亦即先考量願景，再接續考量內外部環境及公司定位後，最後推導出公司的產品組合策略。再根據前述策略推衍出公司的產品組合決策考量因素。研究結果顯示相較於改革前，改革後的累積毛利約為改革前的 3.13 倍，而累積淨利則為 27 倍；故本研究結果有助於補充以往產品組合決策相關研究之缺口，並可供產業界參考之用。

關鍵詞：產品組合決策；市場導向策略規劃方式；作業基礎成本制度；投標市場

Abstract : The literature on product-mix decisions can be categorized into two groups. The studies in the first category compare different cost systems, whereas studies in the second category determine the best product-mix decision using computer simulations or mathematical models. However, product-mix decisions are important not only for the final structure of the product-mix but also for the decision-making process. The comprehensiveness of the decision-making process has a pivotal effect on the appropriateness of the outcome. In particular, in the telecommunications bidding market, pricing and product-mix decisions are indispensable. This is because of certain special features of the telecommunications bidding market. Producers may have many products that conform to the specifications of buyers, but these would have different prices. Each bidding project can have a huge impact on a company's profit or loss. This study considers a communications equipment company operating in the telecommunications bidding market and examines how this company can increase its profits by using activity-based costing to improve its product-mix decision.

After making the improvement, the product-mix decision of the company is based on a market-oriented strategic planning method in which the vision is first clarified. Then, it is followed by an analysis of the internal and external environments. Next, the company's positioning choice is made; finally, the company's product-mix strategy is derived. According to the company's product-mix strategy, the main factors that influenced the product-mix decision are deduced. The results reveal that the accumulated gross profit after the improvement was 3.13 times greater than that before the improvement, and the

accumulated net profit after the improvement was 27 times greater than that before the improvement. The results of this study complement the existing literature and provide implications for companies in the bidding market.

Keywords: Product-mix decision; Market-oriented strategic planning method; Activity-based costing (ABC); Bidding market

1. Introduction

In recent years, accelerated technological innovation has increased competition and shortened product life cycles; meanwhile, customers have also developed diverse and refined tastes. In response to these changes in the technological environment, product diversification and production automation have emerged as two major trends in corporate management. These trends have brought about two effects. First, product diversification has made product-mix decisions and management issues the two most important concerns for corporations. Second, production automation and the increase in the percentage of indirect costs have made the appropriate allocation of indirect costs a very important factor in determining whether product costs can be calculated accurately. In fact, there is a close correlation between product-mix decisions and proper calculations of product costs (Johnson and Kaplan, 1987). Customer preferences differ, and the resources that companies devote to different products and customers vary. Therefore, product cost not only affects selling price but also production strategy (Huang *et al.*, 2010). If a company cannot accurately calculate costs, it will make erroneous decisions and suffer additional losses from selling a higher quantity of products than is necessary. For example, when there is no direct cause-and-effect relationship between the majority of indirect costs and volume-related allocation bases, the traditional cost allocation method (which depends on volume-related allocation bases) leads to what is called cross-subsidization. This, in turn, results in erroneous management decisions regarding product mix and product pricing (Cooper and Kaplan, 1988, 1992; Kaplan, 1989). However, activity-based costing (ABC), which has been proposed

as a means of overcoming the flaws of traditional costing, uses various drivers (including volume-related allocation bases and non-volume-related allocation bases) to allocate costs. This is expected to improve the accuracy of product cost calculations and to lead to an increase in the appropriateness of management decisions.

Certain features of the telecommunications industry, such as the large investment size, limited number of producers, transmission constraints, and transmission losses (David and Wen, 2000), produce stability for both buyers and producers. Also, each bidding project can have a huge impact on a producer's profit or loss. Producers may forego tens of millions of New Taiwan dollars in revenue if they do not win a bid; however, they cannot afford to suffer losses for the sake of outbidding competitors. Furthermore, in the telecommunications bidding market, a producer's product specifications should conform to the requirements of buyers. Producers may have many products that conform to a buyer's specifications, and each product will have a different cost. Therefore, pricing and product-mix decisions are key issues in the telecommunications bidding market. In addition, because the investment size in the telecommunications industry is very large, properly allocating indirect costs is crucial for making appropriate pricing and product-mix decisions.

Product-mix decisions have long been the subject of wide-ranging discussions in management and economics. However, previous research has often focused on the relationship between the Theory of Constraints (TOC), ABC, linear planning or mathematical models, and product-mix decisions. Rarely has research used a real case study to investigate how a company should practically proceed with a product-mix decision. A significant amount of research has examined the relationship between market structure and the efficient bidding strategy for producers. In general, there are three methods for developing an optimal bidding strategy: estimating the market-clearing price, predicting a rival's bidding behavior, and using a game theory model. However, these methods are more appropriate for analyzing the potential market power than for constructing a bidding strategy. This is because many simplifying assumptions have been established in applying these methods (David and Wen, 2000). Our research is

unprecedented because, unlike past research, our study is based on the case study of a real company. We have researched how this company improves its product-mix decisions in the bidding market.

A product-mix decision is a multi-faceted framework that includes many variables, and it produces different product-mix decision results according to the weights and priorities that the firm assigns to the variables. However, firms might have to take into account certain common variables and a common framework. Consequently, when studying the product-mix decision, it is not sufficient to focus on any particular variable. It is also necessary to emphasize the framework of the entire product-mix decision from a macro viewpoint. Furthermore, the product-mix decision is important not only for the final framework of the product mix but also for the decision-making process. The comprehensiveness of the decision-making process has a crucial effect on the appropriateness of the framework. Therefore, this study examines how the company being studied generates a profit by using ABC to improve its product-mix decision in the telecommunications bidding market. This study complements the existing literature and provides implications for companies in the bidding market.

2. Literature Review and Initial Construction of the Product-mix Decision

2.1. The Effect of the Cost System on the Product-mix Decision

Kaplan and Cooper (1998) have identified the ABC method's effects on product-mix management. In the traditional costing system, direct labor hours or direct labor costs are often used as the base for allocating indirect costs and support costs. However, because indirect costs and support costs are very weakly correlated with direct labor, the use of the traditional costing system often leads to an inaccurate assessment of product costs; this leads to an erroneous product-mix decision. However, a company can correctly attribute indirect costs and support costs to products under ABC using resource drivers and activity drivers. Lea and Fredendall (2002) found that the effects of a product-mix decision model based on

ABC are superior to the traditional costing system because ABC is more sensitive to changes in external factors. Sievanen *et al.* (2004) used a case study method to substitute numbers from a real case into the ABC system and analyzed the factors of the company's profitable products using the drivers of ABC system.

The results of Low (1992) and Spoede *et al.* (1994) support the view that the TOC can produce a more profitable product-mix decision model than ABC. However, Kee (1995) found that ABC could produce a more profitable product-mix decision model than the TOC when capacity costs are taken into account. Many subsequent studies used the aforementioned viewpoint as the basis for comparing the merits and flaws of ABC and TOC product-mix decision models. However, these studies did not achieve any breakthroughs.

Sridharan *et al.* (2009) proposed using asset specificity as the standard criterion for product-mix decision systems. If a corporation has high asset specificity, *i.e.*, it has more directly attributed costs, using the ABC method is recommended. Bakke and Hellberg (1991), Holmen (1995), and MacArthur (1993) have all proposed the compromise position that ABC and the TOC are complementary methods with different benefits and drawbacks. Furthermore, because the TOC assumes that direct material costs are the only variable costs, it is recommended for use in short-term product-mix decisions. In contrast, ABC regards all costs as activity related; therefore, it is recommended for use in long-term product-mix decisions. The same conclusion was reached in the discussions by Tsai *et al.* (2008) on the relationships between ABC and the TOC and the product-mix decision model of joint products.

From the studies mentioned above, it is apparent that the TOC assumes that direct material costs are the only variable costs when other resources are fixed, and it is based on a short-term perspective. However, ABC assumes that all resources are variable and is accordingly based on a long-term perspective. In addition, because ABC attributes costs based on activity drivers and resource drivers, it can produce a more accurate product-mix than the traditional costing system. Although the studies are divided in their support of either ABC or the TOC, they place equal emphasis on the importance of costs in product-mix

decisions. That is, costs are the most important consideration in product-mix decisions.

2.2. The Effects of Non-cost Factors on Product-mix Decisions

Lea and Fredendall (2002) used experiments to investigate the effects of using product-mix decision frameworks for manufacturing decision models. They considered four variables: the product-mix algorithm, product structure, management accounting system, and planning period. These four variables correspond to uncertain factors in the real world.

Bayou and Reinstein (2005) studied product-mix decision models using the fuzzy hierarchical model. First, this model is used to decide the development direction of the company. Then, one can draw up the company strategy according to this development direction and break down the strategy into smaller goals.

Similarly, for the research by Bayou and Reinstein (2005), Chen *et al.* (2006) used the modified analytic hierarchy process to determine the product-mix decision model for a new product. The model lists the factors individually and assigns weights to them. Then, it decides the survival time and production quantity of each product according to its weighting score. Chen *et al.* (2006) identified the following 10 factors that influence the success of a new product: (1) quality of human capital, (2) market potential of the product, (3) the product's ability to enter the market, (4) positive net present value (NPV) of income, (5) the product's survival capability, (6) related equipment and assets, (7) the producer's competitors and production experience, (8) the product's technological characteristics, (9) the product's competitive advantage, and (10) technology possessed in the trade. In addition to that, as was pointed out by Letmathe and Balakrishnan (2005), a product-mix decision framework must consider external factors such as regulations, taxes, penalties, and allowances.

A review of the studies discussed in this section reveals that companies have a wide range of qualitative factors. The results obtained will vary depending on the qualitative factors that a company emphasizes.

2.3. An Initial Summary of Factors that Should be Considered in a Product-mix Decision

If the telecommunications market is perfectly competitive, the optimal bidding method for a supplier is to bid at the marginal cost; otherwise, suppliers can increase their profits through strategic bidding, which exploits imperfections in the market (David and Wen, 2000). Consequently, acquiring precise information on costs is crucial in the bidding market. In addition, Shapiro *et al.* (1987) pointed out that the best-selling products might not necessarily bring in the highest profits for their suppliers. They recommended that the company management pay attention not only to product revenues but also to profits. Revenue, cost, and gross profit are the three components of a transaction, and a corporation must consider all three together. A review of the above findings on the effects of costing systems on product-mix decisions reveals that cost is an important factor that influences product-mix decisions (Bakke and Hellberg, 1991; Holmen, 1995; Kaplan and Cooper, 1998; Kee, 1995; Lea and Fredendall, 2002; MacArthur, 1993). It follows that the profit-related factors to be considered in a product-mix decision include sales revenue, cost, profit, and profit rate.

A review of the previous literature shows that factors other than costs should be taken into account in a product-mix decision. These include the product structure (Lea and Fredendall, 2002), quality of human capital, product's market potential, product's ability to enter the market, positive net present value of income, product's survival capability, related equipment and assets, producer's competitors and production experience, product's technological characteristics, product's competitive advantage, and technology possessed in the trade (Chen *et al.*, 2006), regulations, taxes, and allowances (Letmathe and Balakrishnan, 2005).

A review of the previous literature reveals that there are very few studies that address the factors to be considered in a product-mix decision. Furthermore, rarely does the research use actual corporations as supporting examples. This study tries to cover and summarize the factors that were mentioned in previous studies. By a close investigation of one particular corporation, this study attempts to arrive at an understanding of the factors that corporations actually consider

when making their product-mix decisions. From the actual corporate case, the study constructs a product-mix decision framework that conforms to a real industry situation.

3. Research Design

A review of the previous research shows that most investigations into product-mix decisions either compare different cost systems or determine the best product-mix decision model using computer software or mathematical models, or proposes some qualitative factors. However, studies on product-mix decision that compare cost systems or that use computer software or mathematical models simply plugging in assumptive situations and related numbers to arrive at a “theoretical” best framework. In addition, the optimal product-mix decisions that are reached will vary according to differing company strategies, resource qualifications, and financial and non-financial goals. Product-mix decisions are important not only for the final product mix but also for the decision process. In addition, previous studies on market structure and bidding strategies have often used simplifying assumptions in their frameworks. As a result, the equilibrium state they arrive at may not make sense for building a practical bidding strategy (David and Wen, 2000).

This study investigates issues pertaining to a corporation’s internal management, such as how to make practical product-mix decisions, which factors to consider while making these decisions, why these factors are important, and how they are considered in actuality. Therefore, conducting a large-scale questionnaire survey is not an appropriate method. In order to understand the actual operation of a corporation’s internal management system in detail, it is necessary to use the case study method (Bruns and Kaplan, 1987; Ge and Ding, 2008; Yin, 2003). In accordance with this view, this study adopts the case study method in order to understand the product-mix decision process in a real corporation.

Company C is chosen as the case study subject. Company C is a Taiwanese manufacturer that specializes in producing and selling cellular repeaters (*i.e.*, cell

phone indoor signal products). Company C is the second largest producer in Taiwan, and its market share rate is approximately 35%. Its products are regulated telecommunications products, and a concession license is required to sell them. The telecommunications industry in Taiwan has always used the bidding method to purchase equipment. This means that when one telecommunications company needs to purchase repeaters, it sends its purchase order to all qualified suppliers. The qualified suppliers then bid anonymously with the lowest bidder winning the bid; each bidding project is worth at least NT\$10 million.

Because of this characteristic of the telecommunications industry and the size of this company, Company C appears suitable for our case study.

Company C could lose tens of millions of New Taiwan dollars in revenue if it fails to win a bid; however, it cannot afford to suffer losses for the sake of outbidding its competitors. In addition, because both the manufacturers and sellers of repeaters need to possess licenses, there is stability with both buyers and vendors in the market. Furthermore, in the telecommunications bidding market, a producer's product specifications should conform to buyers' requirements. Producers might have many products that conform to a buyer's requirements, and each product will have a different cost. As a result, the Company C needs a concrete, clear, and stable product-mix decision. In addition, the clients of Company C have requested customized products, meaning the company has to produce increasingly diversified products. However, even though the subject company diversifies its products to meet customer requirements or lowers prices because of stiff competition in the bidding market, it must not sacrifice its profits, because multiple products meet the specifications of each bid. Therefore, the key elements that actually affect the profit of the company are the true cost of each product and product-mix decisions for determining the product that should be included in the bid. Moreover, both before and after the improvement of its product-mix decision, Company C targeted the market for mid- and low-end products. Hence, the target market did not have a great impact on the company's decreasing profit. The above analysis shows that the main causes for an increase in sales and a decrease in profits for the company were pricing (*i.e.*, the true cost for each product) and the product-mix decision. Therefore, Company C resolved

to improve its product-mix decision.

After the improvement, its management felt greater confidence in its product-mix decisions. The company increased its profits, which demonstrates the usefulness and effectiveness of the improved product-mix decision process. An examination of this process and the results is helpful for gaining an understanding of the factors that should be considered in product-mix decisions in the bidding market. It also helps understand the relationship between the factors and the product-mix decision.

The information collection procedure is described as follows. On-site interviews were conducted, and related documents and information were collected and studied. The interviewed subjects were the director-general, the chief technology officer, an associate manager of research and development (R&D), and a financial manager. Fifteen interviews were held, and the average length of a session was three hours. There were six additional sessions of phone interviews and fact confirmations. Finally, responses from different interviewees were crosschecked and confirmed to ensure the objectivity and reliability of the collected information.

4. Overview of the Case Study Company

The history of the mobile phone market began with the first generation of analogs in the 1980s, which was followed by the second generation of digitals in the 1990s and the third generation of W-CDMAs in 2000. Company C was founded in 1991 between the development stages of the first-generation AMPS and GSM.

The early telecommunications market was a monopoly seller's market. In Taiwan, the monopolist was Chunghwa Telecom. Consequently, sellers often ignored the infrastructure-related demands of consumers who had to put up with the seller's poor communication quality. Mobile Telecom adopted wireless radio frequency (RF) transmission. Interference from mountains or tall buildings resulted in many dead zones; indoor reception quality was even worse because most buildings were made of concrete. For these reasons, mobile phone indoor

signal improvement products were sold.

In 1997, Taiwan's telecommunications market became more open and began to use European mobile phone specifications (GSM), which resulted in the breakup of the Chunghwa Telecom monopoly. The new telecommunications industry was more consumer-centric; consequently, demands for improvement in indoor reception quality increased. At the same time, Company C and its competitors' sales growth improved greatly; however, large international companies still dominated most markets with their superior technology and capital strength. Consequently, signal enhancement in large indoor shopping malls was accomplished using equipment from European or American companies. However, telecommunications companies used products from small domestic companies, including Company C, for similar but less important indoor areas such as small restaurants. From 1997 to 2001, Company C was left only with the low-level market because of competition from large international companies.

After 2002, due to growth in technology and construction levels that were at full capacity, various telecommunication companies gradually transferred construction to smaller areas. For every year from 2002 to 2005, the telecommunications companies had budgets for improving small indoor signals. Most orders for equipment went to Company C, Remo, and other domestic companies that subcontracted Korean products.

In 2005, Taiwan entered the third generation (3G) era. 3G applications include video and other media that enable a broader use of mobile phones than the second generation (2G) technology. Therefore, the indoor signal equipment requirements of the 3G era far surpassed those of the 2G era. Currently, Company C must face its major domestic competitor, Remo, as well as Korean competitors supported by the Korean government. In the past, these firms have repeatedly taken control of the Taiwanese market with their low prices. In addition to the original competitors in the international market, companies in China, Korea, and India, with their own large domestic markets and government protection, have begun to pursue the international market. In response to this change in business climate, Company C has transferred its business focus to overseas markets. Since 2006, the proportion of Company C's sales in overseas markets has gradually

increased; in mid-2007, overseas sales accounted for 45% of its total sales.

Company C's total capital amounted to NT\$70 million in 2006, and its annual revenue was approximately NT\$3 billion. Ninety-five percent of its business transactions were conducted through the bidding method. Its ratio of domestic revenue to foreign revenue was 2:1. Foreign business was conducted by selling self-developed brands through product distribution contracts signed with licensees from many countries. The sales products can be classified as self-manufactured repeaters and licensed import products. Regarding licensed import products, Company C collaborated with advanced manufacturers in Europe and the United States and began importing cutting-edge products in 2000. In order to distinguish itself from the major international brands, it mainly targeted the small- and medium-frequency markets with its self-manufactured repeaters. Its target products fell under the following three categories:

- (1)*Customized repeaters*. The frequency details of these products can be customized according to customer specifications, and they are made-to-order. The production period for products in this category is longer, and customers face a longer waiting period. Most of the customers of this product are telecommunications companies or their system supply partners in Taiwan and abroad. According to their transmission efficiency, these products can be classified as E-series, D-series, or C-series.
- (2)*General repeaters*. These products use the standard frequency of cell phone systems. Most customers are restaurant, department store, or wholesale superstore owners. These products are standardized and can be manufactured in small quantities. According to their transmission efficiency, these products can be classified as G-series, B-series, or L-series.
- (3)*Automobile cellular repeaters*. Due to geographic limitations or financial concerns, local telecommunications companies in some European and American countries have been largely unwilling to devote resources to building telecommunications infrastructure that could improve transmission quality in suburban and mountainous areas. However, many people living in these areas must drive for two to four hours between home and work each day. To resolve the communication difficulties faced during long-distance

commuting, Company C launched Series A, an automobile cellular repeater.

From the above, it can be seen that the company has diverse product categories. There are significant differences between the different series of its products, and these differences extend to the product costs. Thus, it is very important for this company to define product costs clearly and properly analyze its product-mix decision.

5. The Product-mix Decision Before Improvement and its Challenges

Before the improvement, the company's product-mix decision was very simple. As long as customers accepted the price of a product, the company would manufacture and sell the product. The pricing method calculates the total production cost as follows: (direct material cost + direct labor cost + manufacturing cost) \times (1 + target gross profit rate). The target gross profit rate is subjectively decided by the director-general, whereas the manufacturing cost is allocated according to the cost percentage of each product material.

Company C faced increasingly fierce competition. On top of the competitive price slashing among domestic competitors, Korean manufacturers, who were supported by the Korean government, broke into Taiwan's market with a low-price strategy. In addition to European and American manufacturers, manufacturers from China, Korea, and India were entering the international market on the strength of their own enormous local markets and their governments' protection. Along with facing a fiercely competitive environment, the company was experiencing major internal problems. In order to satisfy its sales personnel's need to deliver its public-oriented general repeaters quickly, the company had accumulated products of different series. Due to improper allocation of production power and resources, the company often produced products that did not conform to client specifications, which led to escalating costs.

At the same time, the company did not properly manage information about the various service costs provided by its logistics department, and its target gross profit rate was subjectively decided by the director-general. This meant that the

costs arrived at by the logistics department were not considered during the pricing stage, and it was not possible to clearly discern the costs of various products or their contributions to the company's profit. Matters soon reached a point where pricing was subjectively decided by the director-general while the sales personnel busied themselves with selling; this could have led to a generation of debt-incurring orders. In addition, clients continued to demand customized products, which led to the company's products becoming even more diversified with prolonged production times and management problems. In this situation, efforts to improve the sales volume and sell more products led to a falling profit rate (see Table 1). In addition, the percentage sales of popular and low-margin products of Company C did not increase. On the contrary, the percentage decreased year after year (as shown in Table 2). Relatively, the weighting of customized products rose year after year. In 2005, it even reached 40%. Therefore, profits decreased from 2001 to 2005 even though sales increased due to an increase in the proportion of customized products. Nonetheless, the company did not have a sound costing system and thus offered an inappropriate product (*i.e.*, a product of higher cost) in the tender. Meanwhile, competition had resulted in price lowering among the competitors. Because a variety of products within a company may comply with the specifications of a bid request, the company does not have to raise the price of an undervalued product when faced with a price cut. Instead, in fulfilling the request for a bid, it can respond by selecting a product with a lower cost to secure profits to a certain extent. In other words, by grasping the true product cost and selecting the right product for the tender, a company can retain its profit. Therefore, the key elements that affect profitability of a company are the comprehension of the true costs of products and a strategic product mix for participating in the tender. After having recognized its root problem, Company C decided to improve itself.

Table 1

Sales Volumes and Net Profit rates of Company C from 2001 to 2005

Year	2001	2002	2003	2004	2005
Sales volume (Units)	4,043	4,211	4,532	3,482	6,987
Profit rate	9%	8%	9%	7%	5%

Table 2**Sales Volumes from Popular and Low-margin Products and Customized Products Over Total Sales Volumes of Company C from 2001 to 2005**

Year	2001	2002	2003	2004	2005
Sales volumes from popular and low-margin products over total sales volumes	21%	20%	18%	17%	16%
Sales volumes from customized products over total sales volumes	23%	28%	31%	35%	40%

6. BC Implementation and Product-mix Decision Improvement

6.1. BC Implementation and its Structure

Company C was deeply aware that the problems with its product-mix decisions stemmed mainly from the lack of accuracy in its cost calculations. The company's management learned that the ABC method is a cost calculation method that is ideal for clarifying the costs of diverse products that are produced in small quantities. They also learned that management could use the information obtained via ABC in product-mix decisions, which could possibly lead to a better product mix. Because the product-mix decision of the company was based on long-term considerations, the management decided to introduce the ABC system. It used ABC to obtain the cost information needed for its product-mix decision and then reevaluated and amended the entire framework. The company officially launched its ABC project on January 5, 2005. The planning phase extended from January to August, and the data collection was done in September. To successfully introduce and launch its ABC project, the company established an ABC project team whose members included a project manager director-general, a project implementation consultant, directors along with their project personnel, and information engineers. The director-general was responsible for interdepartmental communications and progress tracking progress. The project implementation consultant was responsible for planning and implementation. The directors of each department and their project personnel were responsible for the system design for their own

departments, personnel education training, and participation in interdepartmental meetings. The information engineers were responsible for writing the software after communicating with the implementation consultant.

In addition to considering direct material costs, direct labor costs, and manufacturing costs, the ABC system also takes into account the supporting costs of the logistics department. First, it divides the company's entire resources into manufacturing department resources and other department resources. Then, after calculating each model's manufacturing cost using the information on manufacturing department resources, it assigns the resources of other departments to specific models. Then, it can deduct the model manufacturing costs and the supporting costs of other departments from the corresponding product sales amount to obtain the profit amount for each product. In terms of resource expenses related to labor in the manufacturing department, it can allocate resources to specific activities according to activity hours and then allocate activity costs to specific product models according to model labor hours. As for the remaining labor costs not directly related to the models, it allocates them evenly across all products according to production amounts because they cannot be allocated directly to particular models according to model labor hours.

Regarding other resource costs unrelated to labor, apart from attributing direct material costs to specific models according to the bill of materials (BOM), ABC can attribute other costs evenly across all products according to production amounts. For other departments, the labor-related expenses amount to 80% of the total expenses. The company attributes the labor-related resource expenses to specific activities according to activity hours and then attributes the classifiable activity costs to specific models according to model supporting labor hours. Other labor-related expenses not directly related to specific models are allocated evenly across all products according to specific production amounts because they cannot be attributed directly to specific models according to model supporting labor hours. The remaining resource expenses unrelated to labor are allocated evenly across all models according to specific production amounts.

Company C produces a wide variety of products, and large differences exist among the different products; in particular, the manufacturing difficulty levels

were very different. Therefore, ABC attributes costs according to the labor hours of specific models. For example, the labor hours of a specific product equal the production amount multiplied by the product series manufacturing difficulty score (see Table 3 for the manufacturing difficulty weighted scores of all product series). The company began to collect relevant cost information through the ABC system in September 2005 and started implementing the post-improvement product-mix decision on April 1, 2006 in order to update its product mix based on the collected information.

Table 3
Weighted Scores of Manufacturing Difficulties of Various Product Series

Product series	E	D	C	B	G	L	A
Weighted Scores of the Manufacturing Difficulty	5	4.5	3	2.5	2	2	1

6.2. The Post-improvement Product-mix Decision

The company's product-mix decision before the improvement had only one specification: the sales personnel could sell a product if the sales price was higher than the minimum price set by the company. However, in the face of an increasingly competitive market, the company was forced to rethink its product-mix decision. High-ranking management personnel read pertinent documents, engaged in internal discussions, and consulted with professionals in academia. Then, they opted to adopt market-oriented strategic planning to rethink and amend the company's product-mix decision. Market-oriented strategic planning means maintaining a management sequence that includes vision, environment, positioning, and strategy to maintain proper interactions between an organization's goals, technology, resources, and changing market opportunities (Kotler *et al.*, 1999).

The term "vision" has three dimensions: Technology, Market, Leverage and Scalability. Case company's vision is mainly formed by Market. The term "environment" mainly refers to a company's external and internal conditions; environment is usually analyzed using Porter's five forces model. The following

are descriptions of the five forces of this model.

(1) Competition from alternatives

Company C's products were originally cheaper than base stations; however, due to recent technological improvements and mass production techniques, the once high-priced base stations are no longer costly. Certain base station prices have fallen close to the prices of high-level products, meaning they can be used as cost-effective alternatives. However, in the low- and mid-level product markets, from a cost viewpoint, there is no alternative that can fully substitute for the products of Company C.

(2) Potential threats from entrants

Because of easy access to production technology and the progress of the semiconductor manufacturing processes, it is not overly difficult for low- and mid-level products to enter the market from the viewpoint of technology. From a marketing viewpoint, however, regional characteristics, the government, and regulatory restrictions require entrants to have considerable financial resources to support long-term relationships with customers, and a number of breakthroughs must be made concerning laws and regulatory restrictions.

(3) Confrontation with existing competitors

Because Company C's production technology is established in the industry, unless there is a special requirement, many manufacturers can offer substitutes. In general, telecommunications customers often have open budgets for purchasing products, and this allows two to three manufacturers to compete to maximize their profits. Company C and its competitors have relatively less profit due to lowering their prices to win bids.

(4) Buyer's price negotiation ability

Because 2G and 3G licenses are limited resources, there are only a few telecommunications companies operating in any country or region. In the 1990s, sellers could obtain a high price because the technology was concentrated in the hands of a small number of manufacturers and buyers did not have sufficient information. However, today there are more participating manufacturers, and it is possible to obtain information easily over the Internet; consequently, buyers have a greater ability to negotiate prices.

(5) Supplier's price negotiation ability

Because of the development of semiconductors, many key components have been developed into ICs. This development can help reduce a large portion of its direct costs. However, because the company product is industrial, the component procurement amounts are significantly smaller when compared to consumer electronics such as mobile phones. This has resulted in a decrease in the price negotiation ability of the company. In addition, the suppliers of the company's product are inferior to suppliers in the consumer electronics industry.

Next, the term "positioning" mainly refers to the fact that at different points in time, Company C makes different positioning choices in various external environments. In general, the SWOT model proposed by Ansoff (1995) will be used in the analysis. Descriptions that pertain to this model are given below.

(a) Strength

Company C is a non-public company, and the chairperson is also the general manager; hence, its organization is more flexible than that of a public company. Its development is also not easily affected by external laws and regulations. Therefore, the company's strength is that its organization can expand rapidly and operate a flexible work environment.

(b) Weakness

As was mentioned above, Company C is a non-public company. Therefore, the company has fewer funds, and it has more difficulty attracting talented employees. In addition, its technical capability is low.

(c) Opportunity

The 3G market is booming, and the popularity of mobile phones has increased yearly. Therefore, the company's product market is expected to grow.

(d) Threat

The rate of progress of large international companies is far greater than that of Company C. Therefore, when the technological distance between Company C and the large international companies increases, the overall production value of the 3G market grows. In such a case, the company might not experience an increase in profit or sales.

Finally, we will discuss this company's product-mix strategy. From the above

analysis, it is clear that the company's vision was mostly determined by the market, which means that the company placed the highest value on the market structure in its vision. From the industry market analysis, one can see that the company's product market is a buyer's market. Because equipment purchases in the telecommunication industry are made through bidding, it is necessary to manage relationships with clients on a long-term basis. Moreover, because Company C is not a publicly traded company, it has limited resources and labor. Because of its ability to respond to changes quickly, it targets the low- and mid-level product markets. In addition, because of advances in the IC industry, it is not prohibitively difficult to produce products similar to those produced by Company C. It is also noteworthy that, because each bidding project is worth at least NT\$10 million, the company must focus on the accuracy of product cost calculations. Furthermore, both the manufacturers and the vendors of repeaters need to possess licenses, so there is stability between buyers and sellers in the market. New competitors or buyers rarely appear in the market; therefore, whether a project is won is determined by the company's long-term management policy. Because of these considerations, Company C chose "market prospect and cost accuracy" as their product-mix strategy. This strategy focuses on the opportunity in the target market, the competitive conditions of the target market, and the sales performance that is achievable in the market. Because the company emphasized cost accuracy, the product profit rate and product profit contribution are also considered. It is evident that the four major factors in the company's product-mix decision framework are (1) target market opportunity, (2) competitive market conditions, (3) profit rate, and (4) sales performance and profit contributions. In addition, the management acknowledged that it made mistakes when exercising judgment on the product mix, and these mistakes varied according to situation. Therefore, it added the factor of alternative projects in order to be more comprehensive. These four major factors would address the challenge of alternative projects². If the company remained unable to solve the

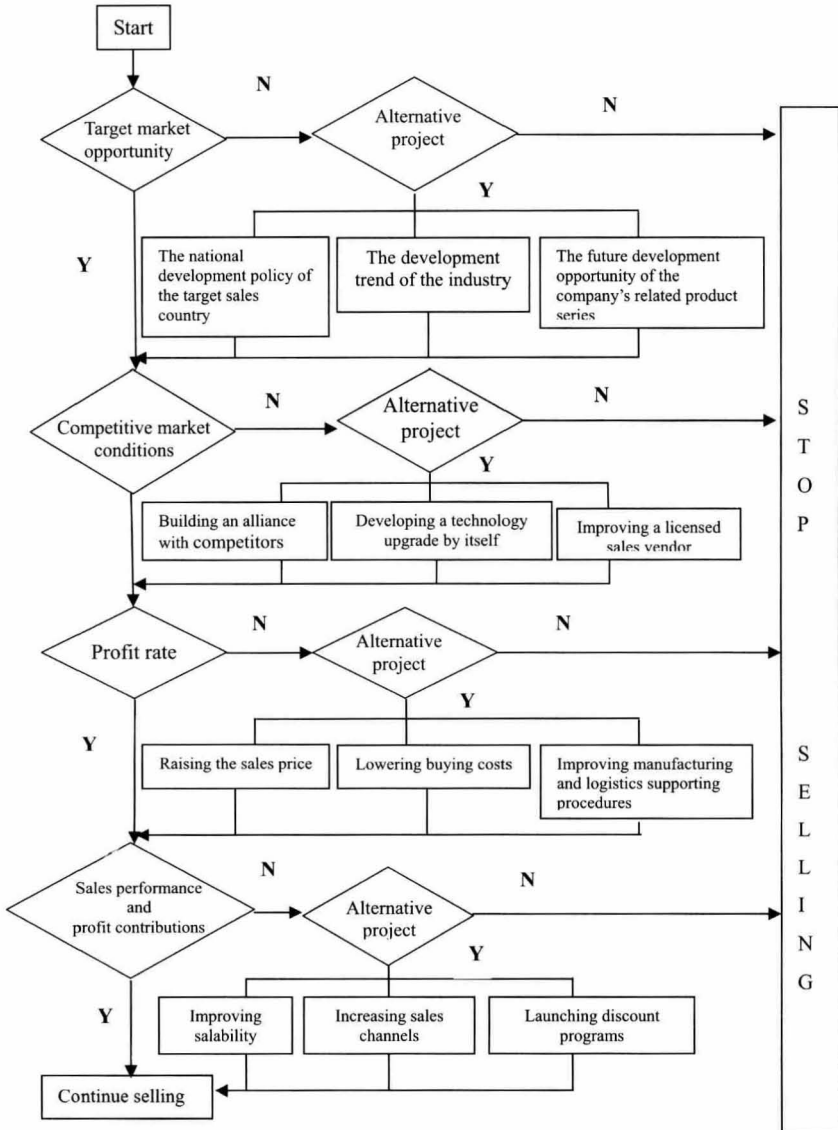
² The "market-oriented" strategic planning adopted by the company was to develop and maintain a management process so that the goals, technology, and resources of the organization were appropriately adapted to changing market opportunities. First, the vision of the company was

problem after considering all alternative projects, it would choose to abandon production of the product. The company's post-improvement product-mix decision framework is summarized in the run-down diagram in Figure 1.

Figure 1 shows that the company first considers the target market opportunity (*i.e.*, the possible sales scale) when evaluating the viability of a product. If the scale is not large, it considers whether there is an alternative project. After discussions between the director-general and the two sales associate managers, relevant documents are consulted and the alternative project is analyzed according to (1) the national development policy of the target sales country, (2) the development trend of the industry, and (3) the future development opportunity of the company's related product series. If the target sales country has the potential to ensure sound development for the industry, then the project passes the target market opportunity test. The company next proceeds to consider competitive conditions in the market (*i.e.*, the existing rivals in the target market, competitiveness of the company's products, and market regulations). When a particular product does not pass the market competitiveness test, the company looks for an alternative project such as (1) building an alliance with competitors, (2) developing a technology upgrade by itself, or (3) improving a licensed sales vendor. Then, it considers the profit rate and determines whether it is greater than or equal to the target value. This applies to both the gross profit rate and the net profit rate. The current target gross profit rate is 30%, and the target net profit rate is 0%. If the product cannot meet the company's target profit rate, the company considers alternative projects. The current alternative projects include (1) raising the sales price, (2) lowering buying costs, and (3) improving manufacturing and logistics supporting procedures. Lastly, the company considers contributions to

clarified. Then, the internal and external environments were analyzed. Next, a decision was made for the positioning of the company. Finally, a strategy was deduced for the company. In analyzing the internal and external environments, the five forces included the effects of competitors. A SWOT analysis was conducted to select a position; it considered the external competitive situation of the company for decision making. In addition, the four main elements (target market opportunity, competitive market conditions, profit rate, and sales performance and profit contributions.) that the company took into account in deciding the product mix also included competitive market factors (e.g., prices that competitors may offer). Therefore, we can say that the "market-oriented" strategic plan already includes a "competition-oriented" concept.

Figure 1
Post-improvement Product-mix Decision Framework Chart



sales and profits (*i.e.*, the sales revenues and profits that are brought in by product sales). Again, if the product does not meet the required sales and profit contributions, the company considers alternative projects that would bolster sales, such as (1) improving salability, (2) increasing sales channels, and (3) launching discount programs. However, if there is no alternative project for the product regarding sales

6.3. Comparison of the Post-improvement Product-mix Decision and Previous studies

Table 4 summarizes comparisons between the factors of the company's post-improvement product-mix decisions and the factors mentioned in previous studies.

From Table 4 it is apparent that, of the factors mentioned in previous studies, the factors that the company adopted included the following: the sales revenue, cost, gross profit amount and rate, net profit amount and rate, market potential of products, ability of products to enter the market, survival capability of products, competitors and production experience, technological characteristics of products, competitive advantage of products, and regulations. The main reason why the company considered these factors was that they were relevant to its product-mix strategy of "market prospect and cost accuracy". In contrast to the previous studies, the company's product-mix decision framework included the extra factor of alternative projects. This was to allow the company to respond to various unforeseen incidents and make decision-making more comprehensive.

7. Benefit Analysis After the Improvement of the Product-mix Decision

In this section, we will use a product profitability comparison, bidding project simulated analysis, and statistical tests to demonstrate the benefits of the improved product-mix decision. In order to update its product mix, the company began implementing the post-improvement product-mix decision based on the information it had collected about ABC since April 1, 2006. Therefore, April 1,

Table 4
Comparison of Factors Considered for the Company's Post-improvement Product-mix Decision and the Factors in Previous Studies

Factors	Studies	Factors in Company C's product-mix decision /Explanation for non-adoption
Sales revenue	Shapiro et al. (1987)	(4) Sales performance and profit contributions
Gross profit rate; net profit rate	Shapiro et al. (1987)	(3) Profit rate
Cost; gross profit amount; net profit amount	Shapiro et al. (1987); Kaplan and Cooper (1998); Kee (1995); Lea and Fredendall (2002)	(4) Sales performance and profit contributions
Product structure	Lea and Fredendall (2002)	Because the business model of the company is a bidding system, buyers already clearly define the structure of the products in the bidding contracts; therefore, the company has no decision rights regarding the product structure. Currently, the human resources quality of the company meets the requirement of product technologies; therefore, there is no need to consider the quality of its human resources.
Quality of human capital	Chen et al. (2006)	
Market potential of products	Chen et al. (2006)	(1) Target market opportunity
Ability of products to enter the market	Chen et al. (2006)	(2) Competitive market conditions
Net present value of income	Chen et al. (2006)	Because product competition is fierce, the obsolescence rate is high. The product life span and projected revenue are hard to predict, and the NPV is difficult to calculate.
Survival capability of products	Chen et al. (2006)	(2) Competitive market conditions
Related equipment and assets	Chen et al. (2006)	Because many models have been outsourced, machinery and equipment are not factors being considered.
Competitors and production experience	Chen et al. (2006)	(2) Competitive market conditions
Technological characteristics of products	Chen et al. (2006)	(2) Competitive market conditions
Competitive advantage of products	Chen et al. (2006)	(2) Competitive market conditions
Technology in the trade	Chen et al. (2006)	The company only manufactures after receiving orders; therefore, technology in the trade is not a key factor.
Regulations	Letmathe and Balakrishnan (2005)	(2) Competitive market conditions
Taxes	Letmathe and Balakrishnan (2005)	The products sold by the company do not enjoy tax concessions in the domestic or overseas markets; therefore, the amount of taxes is not a factor.
Penalties	Letmathe and Balakrishnan (2005)	The company produces regulated telecommunication products that must be sold lawfully, and its license will be suspended if there is any violation. Therefore, lawful penalties are not a factor under consideration.
Allowances	Letmathe and Balakrishnan (2005)	The company must obtain allowances before selling its products. Because this is a prerequisite, it is not a factor in consideration.

2006 is used as the point of reference. The period from September 1, 2005 to December 31, 2006 is divided into two segments. First, September 1, 2005 to March 31, 2006 is the period of product-mix decisions before the improvement. Second, April 1, 2006 to December 31, 2006 is the period in which the post-improvement product-mix decision was adopted on the basis of the ABC information.

7.1. Profitability Comparison for Products Before and After the Improvement

This section describes the periods before and after the improvement and classifies product costs as manufacturing costs and logistics supporting costs. Profits from which only manufacturing costs have been deducted are referred to as gross profits. Profits from which both the manufacturing costs and logistics supporting costs have been deducted are referred to as net profits. A comparison of costs is presented to demonstrate the correlation between changing product mixes and different cost structures.

One feasible way to analyze product profitability is the “whale curve”. This curve presents a company’s cumulative profits as a function of products ranked by their profitability. Therefore, we will use a whale curve to analyze the company’s product profitability in this section.

(1) Profitability analysis of products in the pre-improvement period

In general, there are three steps to draw a whale curve. First, we list the sales profits and sales volumes of each product. Second, we accumulate the numbers of total sales profits and total sales volumes and use these two numbers as denominators to calculate each product’s sales profits rates and sales volumes rates. Finally, we rank products by their sales profits rates and draw out the whale curve. Following the above method, we obtained the whale curves representing the cumulative gross profits and cumulative net profits for the pre-improvement period (from September 1, 2005 to March 31, 2006). These are presented in Figures 2 and 3, respectively.

From Figure 2 it is apparent that, if the logistics supporting the costs of the service department were not included, 82.79% of the products would have

Figure 2
Whale Curve of the Product of Cumulative Gross Profits Before the Improvement

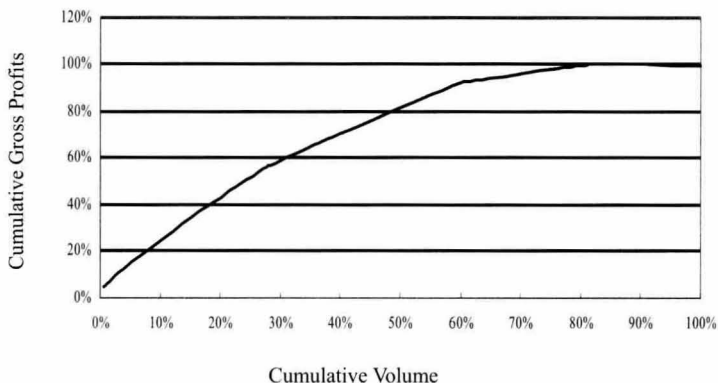
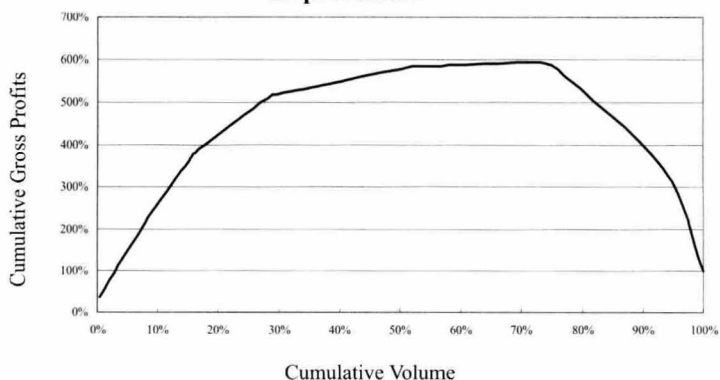


Figure 3
Whale Curve of the Product Cumulative Net Profits Before the Improvement³



³ The denominator was the summation of the net profit from each of the products. Some products made profits, whereas others made losses. Negative net profits were recorded by 26.86% products. Therefore, the ultimate profit after the summation (i.e., the overall net profit taken as the denominator) was not the largest number. Hence, the percentages of net profit for some profitable products in Figure 3 can exceed 100%. If only the net percentages of profitable products were added, the result could be as high as 600%. In other words, the company lost approximately 500% of its net profit with the loss-incurring products.

positive gross profits, whereas 17.21% of the products would have negative gross profits. In addition, from Figure 3 one can see that when logistics supporting costs of the service department are taken into consideration, 73.14% of the products generate 600% of total profits, whereas 26.86% of the products lose 500% of profits, leaving a figure of 100% total profits. The proportion of profitable products drops from 82.79% to 73.14% when logistics supporting costs are considered.

(2) Profitability analysis for products in the post-improvement period

Using the same method, we obtained the whale curves representing the cumulative gross profits and the cumulative net profits for the post-improvement products (for the period from April 1, 2006 to December 31, 2006). These are presented in Figures 4 and 5, respectively.

From Figure 4 it is apparent that approximately 99.05% of the products have positive gross profits, and only 0.95% of the products have negative gross profits. In comparison, in Figure 5, approximately 90.21% of the products have positive net profits, and 9.79% of the products have negative net profits. The proportion of profitable products falls from 99.05% to 90.21% when logistics supporting costs are considered.

(3) Comparison analysis of product profitability of the two periods

If logistics supporting costs are not included, approximately 83% of the products of the pre-improvement period have positive gross profits, whereas approximately 99% of the products of the post-improvement period have positive gross profits. An analysis of the changing products of the two periods reveals that the production of 3-C-0006 and 3-E-0010 (two products with lower than 30% gross profits) was ceased after the improvement. Products that were more profitable were produced after the improvement, which resulted in the accumulation of high gross profits. Because only 25 products result in losses, the cumulative loss does not have much impact. Thus, the accumulative gross profit after the improvement was 3.13 times that before the improvement⁴.

⁴ A cumulative gross profit of approximately 10 million NT dollars was obtained by the summation of gross profits of each product during the period before the improvement of the product-mix decision (from September 1, 2005 to March 31, 2006). Then, another cumulative

Figure 4
Whale Curve of the Product Cumulative Gross Profits
After the Improvement

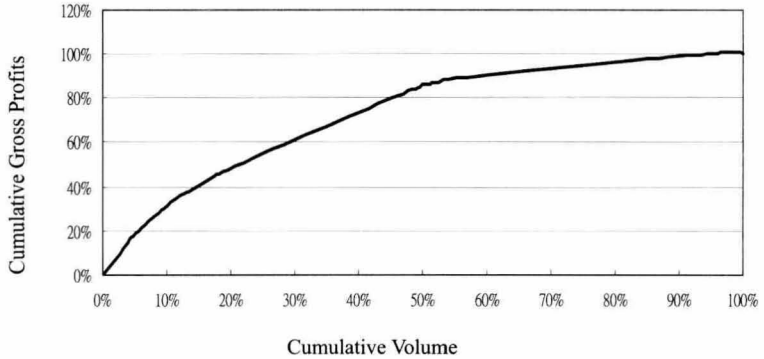
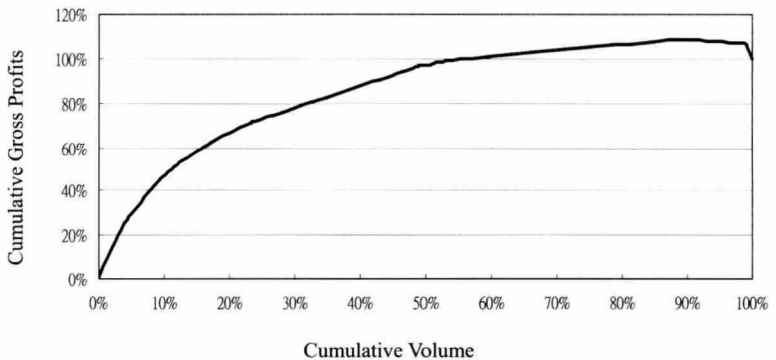


Figure 5
Whale Curve of the Product Cumulative Net Profits
After the Improvement



gross profit of approximately 31.3 million NT dollars was obtained by the summation of gross profits of each product during the period after the improvement of the product-mix decision (from April 1, 2006 to December 31, 2006). Lastly, when the latter was divided by the former, it showed that the accumulated gross profit after the improvement was 3.13 times that before the improvement.

If logistics supporting costs are included, approximately 73% of the products of the pre-improvement period have positive net profits, whereas approximately 90% of the products of the post-improvement period have positive net profits. The analysis shows that four products from the pre-improvement period have negative net profits: 3-E-0010, 3-C-0006, 3-A-0002, and 3-D-0015. The sales of 3-A-0002 and 3-D-0015 were continued after the improvement, whereas the sales of the other two products were stopped. Many profitable new products were launched after the improvement; therefore, the accumulated net profit after the improvement was 27 times greater than that before the improvement⁵. Among the loss-incurring products from the post-improvement period, only 3-A-0002 has a sales figure of 200 units. The reason why the company continued to sell 200 units of product 3-A-0002 was that this batch was from the warehouse inventory. Therefore, irrespective of whether the batch was sold or not, the related manufacturing cost had already taken place. In other words, it was a sunk cost, and selling the inventory would allow the company to recover at least some portion of the cost. Therefore, the company decided to sell the inventory. However, after that, the company stopped producing and selling 3-A-0002. Besides that, sales of the loss-incurring products of other models add up to only 55 units, and the cumulative loss is not very high.

In addition, the sales revenue in 2006, 2007, and 2008 was approximately NT\$300million, NT\$306million, and NT\$327million, respectively. Moreover, the net income in 2006, 2007, and 2008 was approximately NT\$21 million, NT\$22.68 million, and NT\$30.87 million, respectively. Therefore, the financial report for Company C shows a 2% increase in sales revenue in 2007 as compared with 2006 and a 9% increase in 2008 as compared with 2006. There was an 8% increase in the net income in 2007 as compared with 2006 and a dramatic 47% increase in the net income in 2008 as compared with 2006. The increase in sales revenue may be the result of overall economic conditions and competition;

⁵ By summation of net profit of each product, the net accumulated profit of approximately NT\$760,000 was obtained for the period before the improvement of the product-mix decision. This was divided by the profit of approximately NT\$20,620,000 obtained after the improvement. It showed the accumulated net profit after the improvement was 27 times that before the improvement.

however, the cost is also considered in the net income calculation. These results show that the product-mix decision integrated with ABC is helpful for making better product-mix decisions and thereby increasing the company's profits.

In short, this study divided the duration of the product-mix decision for the company into the period before the improvement (from September 1, 2005 to March 31, 2006) and the period after the improvement (from April 1, 2006 to December 31, 2006). In these two periods, the buying and selling markets did not change much. The buyer was mainly a telecommunications company or a system supplier of the telecommunications company. Meanwhile, because repeaters are a regulated product that requires vendors to acquire a sales license, vendors have to make a huge investment. Hence, the sellers did not change much and the bidding competition among the sellers was still fierce. Thus, it is reasonable to assume that the buying market did not swing to the selling market in the periods before and after the improvement. Table 5 shows the relevant data of the overall economic environment in the two periods. According to Table 5, the environment did not significantly vary. Moreover, the company did not change its other systems except for the introduction of ABC and the improvement of product-mix decision. From the above discussion, we see that, excluding other possible internal and external factors, the introduction of ABC and product-mix decisions in the periods before and after the improvement resulted in major changes. Therefore, we can deduce that these are the primary factors for performance enhancement of the company.

7.2. Simulated Analysis of Bidding Cases from the Pre-improvement and Post-improvement Periods

A profitability comparison analysis of the product-mix decision before and after the improvement was performed using actual financial data, as described in the previous section. In this section, the company's actual bidding case (FET001) is used to conduct a simulated analysis. The intent is to reach a deeper understanding of the profits obtained by the company's product-mix decision improvement using another method of analysis. The results of the simulated analysis are shown in Table 6.

Table 5
**Relevant Data of the Overall Economic Environment for Comparison in the
Periods Before and After the Reform**

Item	Period	2005/09/01– 2006/03/31	2006/04/01– 2006/12/31
Average salary in Taiwan's manufacturing industry		41,847	41,990
Taiwan CCI (index)		71	68
Taiwan real PCE, by month		26,299	26,540
Taiwan's real GDP, by month (millions)		996,659	1,045,123
Taiwan's real GNP, by month (millions)		1,022,409	1,066,581
Annual deposit interest rate (%) in Taiwan's five major banks		1.95	2.13
Exchange rate between NTD and USD		32.86	32.60
Taiwan's unemployment rate (%)		3.94	3.92

Note : Source: TEJ

Table 6
Bidding Case Simulated Analysis of the Company

Product-mix decision	Product number	Sales volume (units)	Selling price (per unit)	Product cost (per unit)	Product profit (per unit)	Total gain (loss)
Before the improvement	3-A-0002	500	\$30,000	\$19,000	\$11,000	\$5,500,000
After the improvement	3-A-0002	500	\$30,000	\$32,000	(\$2,000)	(\$1,000,000)
After the improvement	3-A-0001	500	\$30,000	\$20,000	\$10,000	\$5,000,000

From Table 6, it can be seen that, before the improvement of the product-mix decision, the company calculated cost by summing up the direct material cost, the direct labor cost, and the manufacturing cost; the logistics supporting cost was not included. However, post-sale service maintenance was ineffective and the labor hours were too long for product 3-A-0002. Ignoring these factors leads to distorted costs. Additionally, one can see from Table 6 that if the traditional costing system was used to calculate costs, the company would choose to bid on

3-A-0002 after the accounting department calculated a profit of NT\$5.5 million for the project. However, if the ABC method was used to calculate the product cost, the calculated product cost of 3-A-0002 would be NT\$32,000, which makes the total profit negative. This would result in a loss of NT\$1 million, and the difference in calculated profit would be as much as NT\$6.5 million. Therefore, the decision of the company to bid on the product 3-A-0001 would be the correct one.

7.3. Statistical Test for Product Series Manufacturing Difficulty Level and Cost Distortions of the Two Periods

Our statistical tests showed that the higher the product series manufacturing difficulty level, the greater the product series costs distortion. We performed two kinds of tests in this study. In section (1), the total samples are separated into two groups by the median product series manufacturing difficulty level. Next, we investigate the statistical differences between two groups. Moreover, in section (2), we performed a t test to investigate whether there is a significant difference between the E-series (the highest manufacturing difficulty level product series) and the A-series (the lowest manufacturing difficulty level product series).

(1) Separate samples by the median product series manufacturing difficulty level

From Table 3, we can obtain the weighted scores of the manufacturing difficulty for the product series; the median of these scores is 2.5. Therefore, we separated the product series based on the median product series manufacturing difficulty level into two groups: low manufacturing difficulty and high manufacturing difficulty. The former included A-series, L-series, G-series, and B-series (whose manufacturing difficulty weighted scores are less than or equal to 2.5); the latter contained E-series, D-series, and C-series (whose manufacturing difficulty weighted scores are greater than 2.5). Next, we calculate the product cost differences of the two periods for each product series. Finally, the t test is used to determine whether the product cost differences of the two groups are significantly different. The result of the t test is shown in Table 7. From Table 7, it

can be seen that the cost distortion of high manufacturing difficulty products is significantly larger than that of the low manufacturing difficulty products under the traditional costing system ($t = -4.97$, $p < 1\%$). Consequently, these data provide statistical evidence that as the product manufacturing difficulty level increases, it becomes more beneficial to use ABC to compute costs.

(2) Compare the highest manufacturing difficulty level product series and the lowest manufacturing difficulty level product series

Among the seven product series, the highest manufacturing difficulty level product series is the E-series, and the lowest manufacturing difficulty level product series is the A-series. Next, we calculate the product cost differences of the two periods for these two product series. We also used a t test to investigate whether there is significant difference between the product cost differences of the two product series. Table 8 supports the findings that the cost distortion of high manufacturing difficulty products is significantly larger than that of low manufacturing difficulty products under the traditional costing system ($t = -2.03$, $p < 10\%$).

Table 7
The Empirical Result of Product Series Manufacturing Difficulty Level and Cost Distortion (I)

Manufacturing difficulty level	Mean cost differences of the two periods	Standard error of cost differences of the two periods	t-value	p-value
Low manufacturing difficulty group	-113.2	97.88		
High manufacturing difficulty group	12,269	5,732.7		
Differences	-12,382.2	491.6	-4.97	<.0001***

Note : *** $p < 1\%$.

In other words, we find that the company has more and more customized products, and from the results of the t test above, we can conclude that under the traditional costing system, the higher the product series manufacturing difficulty level, the greater the product series costs distortion. Therefore, it is very important for case company to compute product costs correctly and properly analyze its

product-mix decision so that it is feasible to increase profitability by the product-mix decision based on ABC.

Table 8
The Empirical Result of Product Series Manufacturing Difficulty Level and Cost Distortion (II)

Manufacturing difficulty level	Mean cost differences of the two periods	Standard error of cost differences of the two periods	<i>t</i> -value	<i>p</i> -value
A-series (lowest)	596	622		
E-series (highest)	12,269	11,465		
Differences	-11,673	10,834	-2.03	0.088*

Note : * $p < 10\%$.

8. Conclusions

In today's environment of fierce competition, customers are demanding diverse products, and the life spans of products are shrinking. The trend of producing diverse products in small quantities has become inevitable for many corporations. This highlights the importance of the product-mix decision. In discussing the product-mix decision, apart from understanding the decision-making process, one must adopt a macro viewpoint to evaluate the structure of the product-mix decision framework, because the evaluation and the comprehensiveness of the decision-making process effects the final decisions made. However, very few past studies have used the case study method to investigate empirically how a corporation proceeds with its product-mix decisions in the bidding market. This study used Company C as its subject. Company C participates in the telecommunications bidding market and underwent improvements regarding its product-mix decision. Using the case study method, we investigated how Company C practically implemented its product-mix decisions and the factors it considered. Then, the study compared and analyzed the product-mix decision before and after the improvement.

The investigations reveal that the product-mix decision of the company after the improvement is based on a market-oriented strategic planning method. Market-oriented strategic planning means maintaining a management sequence, including vision, environment, positioning, and strategy, to maintain proper interaction between an organization's goals, technology, resources, and changing market opportunities (Kotler *et al.*, 1999). According to this method, the company's vision is clarified first, followed by an analysis of the internal and external environments. Then, the company's positioning choice is made, and, finally, the company's strategy is derived. According to the company's strategy, the main factors for considering the product-mix decision are deduced. For example, the company's factors include (1) target market opportunity, (2) competitive market conditions, (3) profit rate, and (4) sales performance and profit contributions. The main reason why the company considered these factors was to implement a "market prospect and cost accuracy" strategy through its product-mix decision. In order to respond to sudden incidents in different situations, it added an alternative project factor into its deliberations to make it more comprehensive. By integrating these related factors, it is possible to make an appropriate product-mix decision. It is also noteworthy that, besides improving its product-mix decision, the company introduced the ABC system into its routine procedures.

To summarize, the company used ABC to furnish the necessary cost information for its product-mix decision; after eliminating unprofitable products, it considered market factors. In addition, by obtaining information on product costs, it could investigate the component factors that affect its costs, enabling it to proceed with its improvement efforts. Moreover, by comparing product profitability before and after the improvement and the simulated analysis of bidding cases, this study demonstrates the benefits of post-improvement product-mix decisions using statistical methods. Finally, the results reveal that the accumulated gross profit after the improvement was 3.13 times that before the improvement, and the accumulated net profit after the improvement was 27 times that before the improvement. It follows that a product-mix decision based on a

market-oriented strategic planning method integrated with ABC is efficient in raising company profits in the bidding market of the telecommunications industry.

9. Limitations and Future Research Directions

This study used one communications equipment firm, Company C, for the case study; it analyzed the effects of a product-mix decision integrated with an activity-based costing system. Wang (2007) and Colpan (2008) pointed out that the performance effects of strategic factors are contingent on the whole environment. In addition, Isobe *et al.* (2008) proposed that both external and internal factors are significant for the level of improvement. Therefore, different product-mix decisions may be created by different companies in response to different enterprise cultures, external competitive environments, and product characteristics. However, the product-mix decision is not only important in the final structure of the product mix but also in the decision process. Therefore, the decision process examined in this study can serve as reference for companies in the bidding market.

However, the scope of this study is limited to product-mix decisions in the telecommunications bidding market. In the future, researchers could extend the scope of the study to other market structures, such as perfect markets or monopolistic markets, and analyze the differences between them.

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