The design and implementation of activity-based costing

A case study of a Taiwanese textile company

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Abstract

Purpose – This paper describes the design and implementation of an activity-based costing (ABC) system for a textile company in Taiwan.

Design/methodology/approach – An in-depth field investigation by collecting and analyzing 39 months of field data, gathering information from files and archives, direct observation, interviews, and statistical analyses was conducted.

Findings – First, the company's existing cost system adopted a volume-based cost driver to allocate overhead costs to products. While the company devised an "equivalent factor" to take production-complexity into account, the weakness of the metric led to product cost distortions. Second, the existing volume-based cost system ignores the impact of rework processes on product costs. Third, adding complexity-related cost drivers to the volume-based cost driver increases the ability to explain variations in overhead costs. Fourth, the newly designed ABC system incorporates both volume-based and non-volume based drivers, which considers the effect of rework on product costs. Fifth, the existing volume-based cost system overestimates the costs of high-volume products and underestimates the costs of products with high production-complexity. Finally, the company still stays at the analysis phase of the ABC system implementation, possibly due to revision of strategy, no linkage to incentives, lack of MIS support, and inadequate inventory control.

Practical implications – The above findings have implications for companies attempting to implement ABC.

Originality/value – This paper extends prior research in the following. First, it reports on the entire process of ABC implementation for a given company, as well as facilitators/impediments in the process. Second, while most prior research tends to focus on success cases, our study presents a failure case, which has implications for practitioners trying to avoid the same mistakes.

Keywords Activity based costs, Cost drivers, Textile industry, Taiwan

Paper type Research paper

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1. Introduction

This paper discusses the background, process, and results of implementing an activity-based costing (ABC) system in a textile company. With increasing global competition in recent years, the textile industry – as well as other industries – has adopted higher production automation and product diversification. This tendency has rendered cost allocation for manufacturing overhead a critical factor in estimating product costs. The fact that there is no relationship between the majority of the manufacturing overhead costs and their volume allocation basis creates problems. As a result, product costs calculated by traditional volume-based allocation methods will be distorted, leading to "cross subsidy." This, in turn, often misdirects decisions about product pricing, product mix, and the choice to manufacture or outsource (Cooper and Kaplan, 1988a, b; Kaplan, 1988). Alternatively, the ABC system traces and allocates costs to products with cause-effect drivers – including volume-based and non-volume-based drivers – and thus is expected to improve the accuracy of cost calculation, assist in making accurate decisions, and serve as a benchmark for planning and control.

Previous ABC studies have either focused on the design of an ABC system and the comparison of product costs under ABC with those under the existing costing method without much validation on the design (Cooper and Kaplan, 1991; Turney, 1992), or compared the correlations between overhead and various cost drivers without discussing the background and processes of actually implementing the ABC system (Banker and Johnston, 1993; Foster and Gupta, 1990). Since this second set of studies also failed to utilize research findings to design a new cost system or modify an existing one, a discussion of actual implementation and correlations between overhead and cost drivers could assist management in perceiving the benefits of ABC. Research on the determinants of ABC success have often concentrated on organizational behavior issues (Shields, 1995; Shields and Young, 1989), yet seldom have discussed the company's changing attitudes toward ABC implementation. In addition, most prior research had been conducted among companies in Western countries while the experience of ABC implementation in other countries is often ign ored. The increasing importance of Asian countries in the world economy and the impacts of their distinct national cultures on company management both suggest that more ABC research in the Asian context is necessary (Brewer, 1998; Hofstede, 1980). This paper extends prior research by using a textile company in Asia as the research site and integrates a broad range of issues into one study: diagnosing the existing costing system, designing and validating an ABC system, documenting the design and implementation of the ABC system, and identifying factors affecting the success or failure of such implementation. In so doing:

- the comparison of product costs under the two systems; and
- the comparison of correlations between manufacturing overhead and cost drivers are both included.

We collected field data for 39 months, and found that the existing cost system created product cost distortions. Relative to the ABC system, the existing cost system overestimates the costs of high-volume products and underestimates the costs of products with high production-complexity. We also found that the company was not able to move past the analysis phase of ABC implementation (Cooper *et al.*, 1992).

Possible reasons for not proceeding to the action phase include revision of competitive strategy, no linkage to incentive systems, lack of MIS support, and inadequate inventory control in the production processes.

The remainder of this paper is organized as follows. In the next section, we review the literature on activity-based costing. In Section 3, we describe the research methodology. In Section 4, we present the data analysis and report the findings on both existing and ABC systems. We then provide concluding remarks in Section 5.

2. Literature review

Miller and Vollman (1985) report that manufacturing overhead as a percentage of value-added in the electronics and machinery industries increased from about 50 to 70 percent in the period 1855 to 1975. Simultaneously, direct labor costs as a percentage of value added in the same industries decreased from about 50 to 30 percent during the same period. Raffish (1991) surveys manufacturing industries in the USA and found that the costs of direct materials as a proportion of product costs were 45 to 55 percent. He also found that while direct labor cost accounted for about 5 to 15 percent of product costs, the proportion of manufacturing overhead was 30 to 50 percent. Cooper (1987) argues that given the increasing proportion of manufacturing overhead, using volume-based allocation bases, such as direct labor hours or costs, leads to inaccurate cost assignment. Cooper (1988) further suggests that increasing diversification of product volume, product size, and product complexity make the issue of cost distortions under the traditional volume-based costing system more significant. Other studies make similar observations (Cooper and Kaplan, 1991; Turney, 1991; Turney and Stratton, 1992). In the wake of such studies, the ABC system has been adopted to improve the accuracy of product costs.

Research in ABC falls into one of the four following types:

(1) a comparison between the traditional costing system and ABC using the calculated product costs;

(2) a comparison between volume-based cost drivers and non-volume-based cost drivers in explaining variations in overhead;

(3) an examination of success determinants in ABC implementation; or

(4) a survey of ABC practice.

The first category of research often reports case-studies calculating product and/or service costs of a company using the existing costing systems in contrast to a proposed ABC system. Comparisons of the product and/or service costs under the two systems, and an analysis of the difference are also reported (Bhimani and Pigott, 1992; Carlson and Young, 1993; Cooper and Kaplan, 1988a, 1988b; Greeson and Kocakulah, 1997; MacArthur, 1993; Rotch, 1990; West and West, 1997). Most of this research has found that, based on activities analysis, the ABC system provided more accurate product and/or service costs.

The second category of research examines the relationship between cost drivers and overhead, and compares the ability of different types of cost drivers – e.g. volume-related vs complexity-related drivers – to explain the variability of overhead. These studies often use data collected in the field and adopt statistical methods – such as regression models – for analysis. Foster and Gupta (1990) are pioneers in this line of research.

Failing to find that complexity and efficiency related drivers have better explanatory ability than volume related drivers, they explain that the result was due to the poor proxy of complexity and efficiency related drivers, and the difficulty in adopting uniform measures for the variables across various research sites. Subsequently, many research studies continue to investigate cost behavior and find that the complexity drivers, along with the volume drivers, significantly explain the cost variations (Banker and Johnston, 1993; Banker *et al.*, 1995; MacArthur and Stranahan, 1998).

The third category of research examines organizational behavior issues and critical success factors of ABC implementation. Shields and Young (1989) present a 7C model to describe the success factors of ABC implementation, which includes culture, controls, champion, change process, commitment, compensation, and continuous education. Drawing on this model, subsequent studies identify success factors such as top management support, linkage to competitive strategy (especially quality and JIT/speed), training, linkage to performance evaluation and incentives, ownership by non-accountants, adequate resources, and consensus and clarity of the objectives of ABC (Foster and Swenson, 1997; Shields, 1995; Shields and McEwen, 1996). Some of these studies focus on ABC implementation stages and factors influencing the success in various implementation stages (Anderson, 1995; Cooper *et al.*, 1992; Krumwiede, 1998; Malmi, 1997), and found that success factors differed with implementation stages. Other studies have examined ABC implementation from the perspectives of organizational structure, contextual and process factors, and cultural influences (Anderson and Young, 1999; Brewer, 1998; Gosselin, 1997; Major and Hopper, 2005; Morakul and Wu, 2001).

Finally, there are survey studies on the degree of ABC implementation in various industries in the USA and Europe (Bhimani, 1996; Bjørnenak, 1997; Clarke *et al.*, 1999; Cotton *et al.*, 2003; Eden *et al.*, 2006; Innes and Mitchell, 1995; Innes *et al.*, 2000; Maelah and Ibrahim, 2006; Pierce and Brown, 2004; Swenson, 1995). These studies provide the reasons why companies adopted ABC, and most of the results reveal that decision usefulness, organization support, and links to performance evaluation influenced the adoption and implementation of ABC.

It is worth noting that the previous studies comparing the product and/or service costs under different costing systems tend not to illustrate the ability of the cost drivers under alternative systems to explain the variations of overhead. While studies investigating the explanatory ability of cost drivers can provide inputs for designing a new costing system, these studies do not use analytic results to design a new management accounting system. Further, both types of study do not provide detailed descriptions of how and why ABC is implemented. Therefore, including the cost driver analysis and the design process together with the product cost comparisons in a study could provide a more complete picture about the reasons why a company decides to choose ABC and the procedures of how an ABC is designed and implemented.

In cases when the adoption of an ABC system has been suggested, many companies still fail to ultimately implement the system. Studies of the critical success factors related to ABC implementation provide many insights. However, the majority of these studies are based on investigations over a short time frame. Seldom do they compare the results over several years like the work of Innes *et al.* (2000). A follow-up examination in a case like this could enrich our understanding about the related success factors as well as provide suggestions for business practitioners.

Moreover, most of the studies were conducted among companies in Western countries. Only a few studies reported ABC implementation in Asian countries. Nonetheless, these studies have at least raised the issue of culture in the process, which is a move in the right direction (Brewer, 1998; Morakul and Wu, 2001). With the emergence of Asian companies in the world economy, and in light of ever-increasing globalization, it is necessary to examine ABC implementation in an Asian context. The current paper attempts to provide a comprehensive understanding of ABC implementation by integrating cost system comparison, cost driver diagnosis, and organizational behavior issues in one study. A textile company in Taiwan was selected for the investigation.

3. Research method and the case study company

This paper attempts to answer questions such as these: Why does a company decide to adopt ABC? How to design an ABC system? How to implement ABC? How and why do the costs generated by ABC and existing cost systems lead to different outcomes? Why does ABC system implementation succeed or fail? Yin (1989) suggests that a case study approach is suitable for answering these "why" and "how" questions. With our geographical location, and the lack of studies in an Asian context, we thus chose a textile company in Taiwan as the case site.

Established in 1980, and currently maintaining a middle-level position in the textile industry, the XYZ Textile Company is composed primarily of:

- a twisting and knitting factory; and
- a dyeing and printing factory.

Recently, sales of finished cloth have grown and accounts for 69.29 percent of the company's sales. As a result, this paper focuses on the finished cloth from the dyeing and printing factory (Figure 1).

The final product in the dyeing and printing factory, according to the color application specified by customers, can be divided into plain cloth (dyeing) and calico cloth (dyeing and printing). The company also produces "high-functional" cloth, and this requires various additional processing procedures according to the characteristics of the different cloth. For example, the production of some types of cloth requires only eight processing steps, but others require as many as eighteen steps. The company produces cloth in different colors and with various characteristics according to customer demand, which results in great variation among orders. During our study, XYZ had over 200 printing and dyeing products and 1,000 customer orders per month. Consequently, the large variety of total orders coupled with the small volume of each order drove diversification of product characteristics and added complexity to the production process.

Due to the soaring production costs and fierce competition in Taiwan, the company had to compete with potential imitators by lowering their sales price and raising their competitive capability through cost control. Direct raw materials accounted for about 70 percent of total product costs, suggesting that lowering purchasing costs was crucial. However, the fact that XYZ insists on raw material quality gave it weak bargaining power, because there were only a few suitable suppliers. Cost control ultimately rested on manufacturing overhead, since the direct labor and manufacturing overhead accounted for only 2 percent and 25 percent of the total product cost, respectively. Moreover, the manufacturing overhead was nearly 19 percent of the sales price and

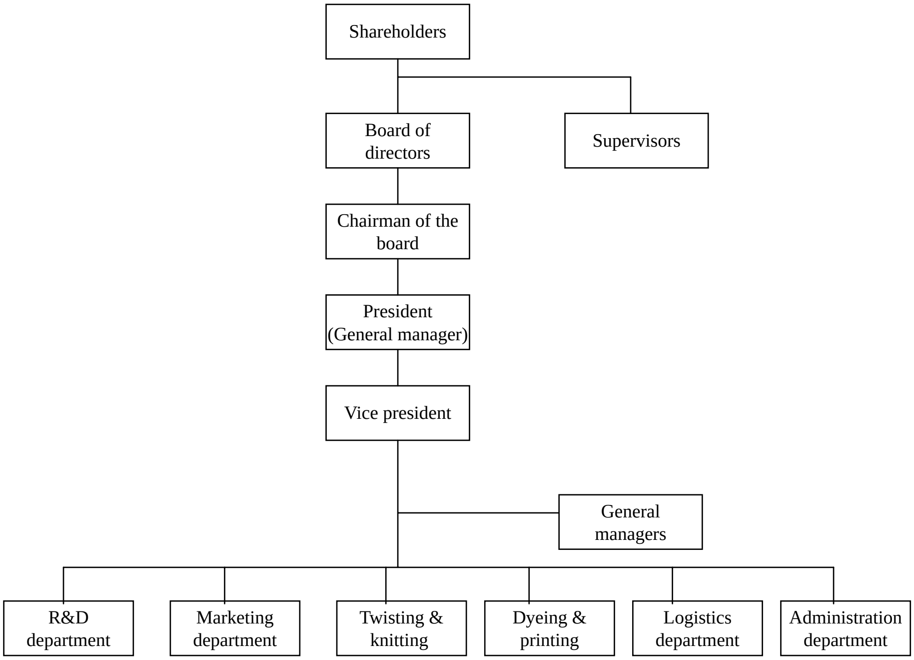

Figure 1.
XYZ textile company organization chart

extremely close to the product margin. Thus, accurate allocation of overhead and timely information on activity costs became critical to successful cost management.

The CEO of XYZ Textile Company was convinced that calculated product costs under the existing cost accounting system deviated from the actual amounts and, therefore, he failed to receive accurate unit cost and useful information for decision-making. He knew the importance of the relationship between product diversification, accuracy of cost calculation, and the effectiveness of decision-making. After reviewing the existing cost system, the company decided to investigate its product cost behavior and found an appropriate way to overcome the drawbacks of the current system. An ABC system, as suggested by prior literature, is the one the company deemed worthy of consideration. Two co-authors of this paper participated in and observed the process of designing and implementing the ABC system in this company.

Following Yin (1989), we collected and analyzed 39 months of field data by gathering information from files and archives, direct observation, interviews, and statistical analyses to understand the company's organization features, production processes, and product characteristics. We built three regression models for cost driver analysis. We then depicted a company-tailored ABC and observed its implementation. Finally, we compared the cost information under ABC and the existing costing system and discussed implementation performance.

4. Data analysis and research findings

4.1 XYZ textile company's existing costing system: characteristics and diagnosis

4.1.1 Existing costing system. The production manager issues dyeing orders according to customer orders and the categories of the finished cloth – this can be distinguished from processing procedures. In this way, the dyeing orders can facilitate the tracking and management of production and sales. The costs of finished cloth are calculated on the basis of the accumulation of dyeing orders, including direct raw material and conversion costs, i.e. direct labor and manufacturing overhead costs.

The direct raw material for finished cloth is greige (raw and unbleached cloth), the costs of which are composed of the unit cost under the monthly weighted average method and the quantity (yardage) needed, which appears in each dyeing order. The conversion costs are calculated by allocating the accumulated total costs of the dyeing and print factory to an individual dyeing order. The method of conversion cost allocation, the focus of our research, is described below in detail:

- The production volume of a current period in yards can be calculated based on the standardized shrinkage allowance rate, wear-out waste rate, and 50 percent completion for products in-process at the beginning and end of the period:

$$\begin{aligned}\text{Current period's production volume} &= \text{current period's finished product volume}\\ &\div (1-\text{shrinkage allowance rate})\times(1+\text{wear-out waste rate})\\ &-(\text{work-in-process' inventory volume at the beginning of the period}\\ &\times 50\text{ percent}) + (\text{work-in-process' inventory volume at the end of the period}\\ &\times 50\text{ percent})\end{aligned}$$

- The equivalent production volume is the product of the current production volume and an "equivalent factor;" a standard weight calculated by the R&D department to allocate facility costs according to complexity variations among different processes:

$$\begin{aligned}&\text{Processing costs of the equivalent production volume}\\ &= \text{current period's production volume}\times\text{equivalent factor}\end{aligned}$$

- Allocate the current processing costs to each dyeing order, based on the proportion of the dyeing order equivalent volume in relation to the total equivalent production:

$$\begin{aligned}&\text{Processing costs added in a current period}\\ &= (\text{processing costs' equivalent production volume}\\ &\div \text{total processing costs' equivalent production volume})\\ &\times \text{total processing costs of current period}\end{aligned}$$

- Calculate the unit cost of an equivalent production volume by using a weighted average method and allocate it to the work-in-process inventory at the end of the period:

$$\begin{aligned}
&\text{Processing costs of the work-in-process inventory at the end of period}\\
&= (\text{processing costs of the work-in-process inventory at the}\\
&\quad \text{beginning of the period} + \text{processing costs added in current period})\\
&\div [\text{current period's finished product volume} \div (1 - \text{shrinkage allowance rate})\\
&\times (1 + \text{wear-out waste rate})\\
&+ (\text{work-in-process' inventory volume at the end of period} \times 50\ \text{percent})]\\
&\times (\text{work-in-process' inventory volume at the end of period} \times 50\ \text{percent})
\end{aligned}$$

- Calculate the processing costs of the current period's finished products:

$$\begin{aligned}
&\text{The processing costs' current period's finished products}\\
&= \text{processing costs' of the work-in-process inventory at the}\\
&\quad \text{beginning of the period} + \text{the processing costs added in the current period}\\
&- \text{processing costs of work-in-process inventory at the end of the period}
\end{aligned}$$

4.1.2 Comments on the existing costing system. Some unique aspects of the company's existing cost accounting system, which impacts the calculation of product costs, are discussed as follows:

- The finished cloth is customer-tailored. The resources used for each dyeing order are apparently different for the diverse customer requirements and various dyeing processes. The existing costing system uses an average allocation method with only one allocation base, and thus it levels the actual costs and fails to demonstrate the cost difference among various dyeing orders.
- The manufacturing processes differ with respect to the requirements of each cloth category; and each process consumes different resources. The current method does not account for this. It merely summarizes the costs of all facilities into one single cost pool and allocates them according to an equivalent factor; it fails to track resources consumed for individual dyeing orders and results in aggregation error (Datar and Gupta, 1994).
- The equivalent factor takes into account the difference in complexity (as measured by activity speed and activity frequency) and in costs (as measured by expense coefficient) among various manufacturing processes. The expense coefficient is calculated as the three-month average manufacturing overhead divided by the three-month yardage average. Since the expense coefficient is updated every few years, the equivalent factor ignores inflation and changes in overhead expense accounts, and hence fails to capture changes in actual production situations. The fact

that the equivalent factor is set up by R&D technicians and not by the production management personnel further contributes to its failure to reflect the actual process of production. Additionally, not all processing costs can be measured by the equivalent factor. For example, dye auxiliaries (additional chemicals used to fix the dyes to the fabric and improve results) and quality test outcomes cannot be effectively measured by the equivalent factor, which will lead to specification error (Datar and Gupta, 1994). Finally, whether or not dyeing orders undergo specific manufacturing processes and use specific dyeing auxiliaries, the processing costs will all be allocated to dyeing orders based on the equivalent factor. Specifically, unrelated costs will be involved in allocation, which will result in "cross subsidy."

- In dyeing and printing operations, quality problems will result in great losses because of delays related to reworking orders. According to actual production data, the percentage of reworked dyeing orders in proportion to typical orders is 48.27 percent. The resources used vary under different rework situations. Although the rework data has been stored in the company's management information system, the existing costing system fails to measure the costs of reworking individual orders and thus leads to cost distortion or "cross subsidy." Measuring the "rework cost" of an individual dyeing order not only can help raise the accuracy of the product cost calculation, but can also serve as a benchmark for activity improvement by providing knowledge about the production processes with the highest rework rates and costs.

4.1.3 Data analysis. Through analyzing the company's business and operations data for the period from January 200X to March 200Y, we sought to determine the sources of the company's manufacturing costs. Specifically, we looked at where the costs would be influenced by product diversification and process complexity, in addition to volume-based drivers, just as suggested in the ABC literature. Thus, in the regression analysis, manufacturing overhead costs, including labor costs[1], indirect materials, equipment costs, miscellaneous costs, and utility costs, serve as the dependent variables. The independent variables include the factors that influence the manufacturing overhead costs, which are divided into volume-based as well as complexity-based factors. The volume-based independent variables are the equivalent volume and the finished product volume of dyeing orders. The complexity-based independent variables, representing complexity – and efficiency-based factors (Foster and Gupta, 1990; Datar *et al.*, 1993; Banker *et al.*, 1995), include the average number of manufacturing processes (average number of processes for manufacturing finished products each month), the varieties of products (number of finished cloth categories produced), rework rates (the rework rates at the dyeing machines, finishing machines, and drying machines), and the capacity utilization rate (actual total volume of production ÷ normal total volume of the production). Based on the data mentioned above, regression equations can be established as follows:

Model 1:

$$\text{Total Manufacturing Overhead Costs}_i = \beta_0 + \beta_1 \text{ Finished Products Volume}_i + \varepsilon_i$$

Model 2:

$$\text{Total Manufacturing Overhead Costs}_i = \beta_0 + \beta_1 \text{ Equivalent Volume}_i + \varepsilon_i$$

Model 3:

$$\begin{aligned}\text{Total Manufacturing Overhead Costs}_i = {} & \beta_0 + \beta_1 \text{ Finished Products Volume}_i \\ & + \beta_2 \text{ Average Number of Process}_i \\ & + \beta_3 \text{ Varieties of the Products}_i \\ & + \beta_4 \text{ Rework Rate at the Finishing Machine}_i \\ & + \beta_5 \text{ Rework Rate at the Dyeing Machine}_i \\ & + \beta_6 \text{ Rework Rate at the Drying Machine}_i \\ & + \beta_7 \text{ Capacity Utilization Rate}_i + \varepsilon_i\end{aligned}$$

The models used are linear regression models. However, some scholars contend that linear regression models by themselves cannot offer adequate explanations for the cost function. Banker *et al.* (1995) developed a log-linear regression model, similar to the Cobb-Douglas model, to analyze this problem. Therefore, we used a MWD (MacKinnon, White, and Davidson) test to verify whether the log-linear regression model exceeds the linear regression model in analyzing company data (Gujarati, 2004). The test, based on regression model three, indicates that the linear regression model is more appropriate than the log-linear one (p-values are 0.640 and 0.069, respectively). Hence, our study adopted a linear regression model to analyze the data.

In performing a regression analysis, it is necessary to test for normal distribution, heteroscedasticity, multi-collinearity, and auto-correlation to ensure the accuracy of the statistical tests and inference. From the chi-squared goodness-of-fit test, the probabilities of the three regression models (0.9837, 0.9837, and 0.8263, respectively; degree of freedom = 2) are large enough that we cannot reject the null hypotheses of normal distribution, suggesting that the residuals are consistent with normal distribution. Moreover, the White test shows that there is no heteroscedasticity in the residuals of the three regression models (Gujarati, 2004). The values of the variance inflation factor (VIF) for the independent variables are between 1.000 and 2.323, showing that there are no significantly linear relations among the variables of our study. Additionally, the results of the Durbin-Watson d test for auto-correlation – 1.514, 1.894, and 1.824 for Models 1, 2 and 3, respectively, – show that there are no auto-correlations for any of the residuals, because the calculated d values do not exceed the significance level of 0.01.

After verifying that the three regression models all maintain the assumptions of the regression analysis, we summarize the results of the regression analysis in Table I. Regression model 3, which includes independent variables concerning production complexity-and efficiency-based drivers, in addition to finished product volume, increases the adjusted R^2 from 0.580 to 0.737. This suggests that incorporating complexity-based cost drivers can better explain the variations of overhead costs than the production-volume-based cost drivers alone. Except for the rework rate at the dyeing machine, the sign of the coefficients for all types of drivers is positive, consistent with our prediction. The negative relation between the overhead and the rework rate at the dyeing machine can be explained as follows. A dyeing machine can

Explanatory variables	Expected sign	Model 1	Model 2	Model 3
Intercept		5.5×10^7 (11.815)*	6.4×10^7 (18.153)*	-2×10^7 (−0.866)
Finished product volume	+	5.583 (7.312)*		3.029 (3.585)*
Equivalent volume	+		0.614 (7.332)*	
Average number of processes	+			6274526 (3.573)*
Variety of products	+			14510.5 (0.738)
Rework rate at the finishing machine	+			1.6×10^8 (3.417)*
Rework rate at the dyeing machine	+			-6×10^7 (−2.194)**
Rework rate at the drying machine	+			3.3×10^7 (2.269)**
Capacity utilization rate	+			4.0×10^7 (2.724)**
R^2		0.591	0.592	0.785
Adjusted R^2		0.580	0.581	0.737
F-value		53.464*	53.760*	16.230*

Notes: [a]Numbers in the parentheses are *t*-values. * and ** are significant at 0.005 and 0.01, respectively

Table I. Results of regression analysis[a]

be fully operated with four tubs. The overhead associated with operating a dyeing machine includes dyes and dying auxiliaries, among others, and thus the more tubs operated, the higher the associated costs. While a regular dyeing job order involves a four-tub operation from the dyeing machine, a rework job order usually involves fewer than four tubs. Thus, when the rework rate at the dyeing machine increases, the associated overhead is decreased. In sum, the coefficients for the finished product volume, the number of manufacturing processes, and rework rates in model 3 are all significant, indicating that the volume-based drivers and the complexity-based drivers can effectively explain the variation of manufacturing overhead.

To summarize, in addition to volume-based drivers, multiple drivers will facilitate improving the accuracy of cost estimation. Through preliminary diagnosis, ABC, which includes the complexity-related cost drivers, will help overcome the drawbacks of the existing cost system and better explains the variations of manufacturing overhead.

4.2 ABC design and implementation

Upon deciding to adopt ABC, the company established a temporary planning team in charge of collecting and studying cases and literature related to ABC implementation, preparing abstracts to disseminate the knowledge for the employees through the company's in-house periodicals, bringing in suitable consultants, and launching on-the-job training in order to enable management and staff to understand the essence of ABC. Furthermore, a "Core Team for the Planning of Activity-Based Costing and Management," or "Core Team" for short, was established to be responsible for overall planning. The Core Team consisted of 12 members: the director of the dyeing and printing factory; a representative from the administration of the dyeing department under the dyeing and printing factory; two representatives from the corporate administration department; the manager of the accounting section under the corporate administration department; two representatives from the accounting section; a representative from the general manager's office (project leader); and two consultants and their two assistants. During the project, inter-departmental specialists were also involved in discussions, including: the head of all sections of the dyeing and printing factory, the information system specialists and the director of the R&D department. Table II presents the ABC design process.

During the design process, the Core Team completed a preliminary ABC model, and performed preliminary calculations and error corrections through on-site interviews, data source verification, and by holding more than 18 meetings (Table II lists the frequency of regular meetings; *ad hoc* meetings are not included). Most activity data required for implementing ABC could be retrieved from the database that was already available, but needed new computer programs for retrieval.

Because cost categories under the existing cost method are not based on ABC concepts, reclassification based on resource consumption is useful. Specifically, the resources that could be traced directly to dyeing orders are separated as independent cost categories and cost pools. For example, the costs of dyeing auxiliaries are separated from indirect materials. Other costs (resources) occurring in the manufacturing and supporting sections can be classified into supplies, labor costs, equipment costs, miscellaneous costs, and utility costs. Table III presents the contents and correspondence of the cost categories between the existing and ABC system.

The manufacturing procedures of a dyeing and printing factory, in general, can be divided into the following categories:

- pre-processing activities, including coloring, drawing, and plate-making, through which customers can confirm the figures of final products;
- on-site facility activities; and
- after-processing activities, including quality inspection, through which customers requirements can be assured, and packaging.

Step	Work item	Number of meetings
1	On-site interviews	2
2	Summarize the information gathered in interviews	1
3	Review and evaluate the existing costing system	2
4	Select activities	2
5	Identify the cost driver associated with each activity	2
6	Determine the items to be collected and the manner by which collect them	2
7	Collect data	1
8	Calculate activity costs and driver rates	1
9	Preliminary data analysis	2
10	Discuss and revise the information in steps 5 to 8	1
11	Data analysis	1
12	Report and discuss the results	1

Source: Core team minutes of the case company

Table II.
ABC design process

Cost category in existing costing system	Contents	Cost category in ABC system
Direct materials	Greige	Greige
Indirect materials	Dyeing auxiliaries	Dyeing auxiliaries
Indirect materials	Supplies	Supplies
Labor costs	Salary, bonus, pension cost, overtime premium, meal expense, and insurance expense	Labor costs
Equipment costs	Depreciation, repair, and insurance expenses	Equipment costs
Miscellaneous costs	Postage, travel, stationery, printing, amortization, and miscellaneous expenses	Miscellaneous costs
Utility costs	Steam, water, and power expenses	Utility costs

Table III. Contents and correspondence of cost categories: existing and ABC costing systems

The after-processing activities are almost identical in each dyeing order and are measured according to either the unit level (yards) or the batch level (number of counts) of the manufacturing volume.

The color prescription and printing plate – the major activities of pre-processing – are prepared for follow-up production. In the case of plain cloth, sales staff will require a test section to prepare various color prescriptions to serve as sales samples. When customers place their orders, the specified greige being used will be colored again in order to ensure a match of the chemical conditions of the cloth and the coloring (a recheck procedure). Therefore, from the perspective of activities in the test section, the coloring sample should not be allocated to the dyeing order, but to the sales staff, and thus be regarded as a sales expense. Additionally, the recheck procedure can be allocated to the dyeing order and become part of manufacturing costs. Similarly, before mass production, the calico will go through drawing, plate making, and testing on the printing machine; the plate can also be used for subsequent orders. In order to accurately measure the costs of each dyeing order that uses different plates, the costs of drawing and plate making can be allocated to the print plate, and the costs of the print plate can be absorbed by the dyeing order that uses that specific plate. Therefore, the dyeing order becomes the primary cost object while the sales staff and the print plate become secondary cost object.

The main production of finished cloth lies in on-site activities. There are 38 kinds of machines, including cloth-carrying machines, twist machines, dyeing machines, drying machines, and finishing machines. Meanwhile, many machines can perform multiple processes. For example, dyeing machines can perform 12 different processes. Finished cloth can be produced from greige through a series of independent processes, and the dyeing orders will undergo different processing depending on the cloth quality and other characteristics. In order to measure the differences among resources used, the processes will be assigned as specific activities and the dyeing order will still be the major cost object. The existing cost system calculates dyeing order costs based largely on standard production processes and ignores the possibility of rework. To accurately measure the details of resource consumption with each dyeing order, ABC will measure rework activities for each dyeing order. Therefore, in the design of the dyeing order code, distinguishing rework processing from regular work is necessary to determine rework costs, and then sum the regular and rework costs to derive the total cost of the dyeing orders.

Let us turn now to the cost allocation bases – cost drivers. In the dyeing and printing factory, the cost of dyeing auxiliaries accounts for 30 percent of the conversion costs. Dyeing orders of different colors and characteristics require different dyeing auxiliaries of various costs. The even allocation of dye costs will lead to great cost distortion. Therefore, it is desirable to allocate dyeing auxiliaries with dyeing orders as directly as possible.

In the ABC model, greige and dyeing auxiliaries are directly allocated to the related dyeing orders. The remaining five cost categories – listed in Table III, which includes supply, labor, equipment, utility, and miscellaneous costs – can first be allocated to production, quality assurance, pre-printing, and pre-dyeing activities. Then, the activity costs of production, quality assurance, and pre-dyeing can be allocated to each dyeing order according to the related cost drivers. In addition, costs of pre-printing activities are first allocated to each printing plate, and then attributed to each dyeing order. Table IV summarizes the activity cost drivers and hierarchies in ABC for the textile company. Finally, it is noted that this ABC model incorporates the regression analysis results. The cost drivers that are used to allocate costs to dyeing orders include both volume-based factors (e.g., length of cloth) and complexity-based factors (e.g., conversion time spent on different manufacturing processes). In addition, rework costs are separated from regular work costs to accurately measure the costs of dyeing orders that differ in rework requirements.

4.3 Comparison of costing information under ABC versus the existing cost system: the validation of ABC

With the assistance of on-site staff, we estimated the product costs of one sample month using the ABC system described in the previous section and generated cost data

Table IV.
Activities, cost drivers, and activity hierarchies

Activity	Cost drivers	Activity hierarchies
Pre-dyeing:		
Coloring	Frequency of coloring	Unit level
Pre-printing [a]:		
Test-coloring	Frequency of coloring	Unit level
Drawing (labor)	Drawing hours	Unit level
Drawing (others)	Number of plates	Batch level
Plate-making (materials)	Direct attribution	Unit level
Plate-making (others)	Number of plates	Batch level
Production:		
Various processes	Conversion time	Unit level
After-processing:		
Administrative support	Number of dyeing orders	Facility-sustaining
Shade matching	Length (no. yards)	Unit level
Full piece cloth inspection	Length (no. yards)	Unit level
Half piece cloth inspection	Number of counts	Batch level
Plastic film packaging	Number of counts	Batch level
Box packaging	Number of counts	Batch level

Note: [a]Costs of pre-printing activities are first allocated to plate numbers based on these cost drivers, and then allocated to dyeing orders according to the associated number of plates used with the existing costing system. To accurately compare the differences between the two systems, we made a comparative analysis with all products in the dyeing and printing factory, and then selected the products with the largest cost difference for further investigation.

According to the data from 1,309 dyeing orders produced in this sample month, the percentage of product cost difference (= [product costs under existing system − product costs under ABC] ÷ product costs under ABC) under the two costing systems ranges from a maximum of 201 percent to a minimum of − 100 percent. To further discuss the possibilities of over − and under-estimation, we categorized the dyeing orders into three groups, based on average yardage (which are shown in Panel A of Table V) to compare the cost difference between the two systems. As Panel A of Table V shows, the costs of dyeing orders of shorter length tend to be underestimated, and ones of larger length tend to be overestimated. As such, the existing volume-based cost accounting system will give rise to "cross subsidy."

We used similar methods to examine the impacts of complexity. Actual processing time itself can serve as a measure of complexity because when complexity is higher, the processing time takes longer. Panel B of Table V shows that, under the existing system, the shorter the processing time, the higher the allocated costs compared to ABC. It also shows that there is "cross subsidy" under the existing costing system. The results of an overall comparison between the two systems are summarized in Panel C of Table V.

Next, focusing on dyeing orders that have considerable over − and/or under-estimation, and are therefore more representative, we analyzed the causes resulting in product cost differences, and compared the difference between the two costing systems. In order to control for the possible effect of work-in-process inventory, dyeing orders were selected from those that were started and completed during the same period.

For the first example, dyeing order 7XY244 with production volume being as low as 125 yards and the equivalent factor of 2.6 was selected. Because the order has low yardage length, the allocated costs are low. However, with a processing time of 5.65 h, rework time of 3.98 h, and expensive dyeing auxiliaries (dyeing auxiliary of 909), the actual costs soared (Appendix I). The costs of a dyeing order under the existing system are under-estimated by 95.75 percent compared to ABC. In the second example, dyeing order 7XY570, the dyeing order volume is 1,283 yards and the equivalent factor is 2.2. However, with an actual processing time of 26.4 h, rework time of 2.17 h, and more expensive dyeing auxiliaries, the actual costs are higher (Appendix II). In this case, the costs of the dyeing order are under-estimated by 83 percent under the existing system compared to ABC.

A good example of over-estimated dyeing orders is dyeing order 7XT055. With a length as long as 20,151 yards, the allocated costs are higher under the existing system, which over-estimated the cost by 90.79 percent compared to ABC (Appendix III).

In addition to the analysis above, through which we discussed the difference in product costs calculated under the existing system and ABC, below we focus on the characteristics of the two systems in which factors such as production volume, actual processing time, rework costs, and the costs of dye auxiliaries can be used to explore the causes of the cost difference under the two systems through statistical correlation

Table V.
Comparison between existing and ABC costing systems

Panel A: Comparison between existing and ABC costing systems by production volume (yards)[a]

Group	*Production volume (yards)*	*Number of dyeing orders*	*Average unit cost under ABC (new Taiwan dollars)*	*Average unit cost under existing costing system (new Taiwan dollars)*	*Overcosting (underecosting)*
A	0 ~ 3,095	716	10,752.07	9,395.68	12.62%
B	3,095 ~ 6,180	211	27,261.06	25,684.82	5.78%
C	6,180 ~	382	82,848.42	89,117.87	7.57%

Panel B: Comparison between existing and ABC costing systems by processing time (hours)[a]

Group	*Processing time (hours)*	*Number of dyeing orders*	*Average Unit cost under ABC (new Taiwan dollars)*	*Average unit cost under existing costing system (new Taiwan dollars)*	*Overcosting (underecosting)*
A	0 ~ 25	762	8.67	15.17	74.97%
B	25 ~ 50	185	24,503.53	25,642.46	4.65%
C	50 ~	362	98,157.62	90,167.78	(8.14%)

Panel C: Comparison between existing and ABC costing systems Summarized

Situation	Existing costing system	ABC system
Production volume:		
High	Higher product cost	Lower product cost
Low	Lower product cost	Higher product cost
Manufacturing process:		
Complex	Lower product cost	Higher product cost
Simple	Higher product cost	Lower product cost

Note: [a]Data was modified to maintain confidentiality, but the original relationships remained unchanged analysis. A discussion of this can also be employed to verify whether the designed ABC reaches its theoretical expectations.

Consistent with the above analysis, the cost differences refer to the difference between the product costs under ABC and those under the existing system. The positive results mean that there is over-estimation under the existing system and vice versa. From the literature and the discussion above, the existing volume-based cost system will lead to a "cross subsidy" of product costs. Thus, the larger the production volume is, the higher the possibility of over-estimation. The equivalent factors under the existing system are based upon the standard processing time calculated with the speed and frequency of processing activities. However, because the raw materials (greige) tend to be affected by storage conditions, greige in different batches produced through the same process and with the same dyeing auxiliaries could generate different final products, giving rise to different rework requirements. Therefore, under the existing costing system, with its focus on only standard processing time (rather than actual processing time) and neglect of rework costs, the costs of dyeing orders with longer actual processing time or with larger amount of rework will be under-estimated In addition, if the dyeing auxiliary cost of an individual dyeing order can be identified, the costs of dyeing orders with higher dyeing auxiliary costs will be under-estimated through the existing costing system. The attribution of the product cost differences under the two systems is listed in Panel A of Table VI.

Correlation coefficients based on data from 1,309 dyeing orders are shown in Panel B of Table VI. It suggests that the cost differences are consistent with ABC expectations and that the correlations are significant at a level of 0.01. The table also demonstrates that the ABC system designed by the Core Team improves the product cost accuracy in that it allocates more costs to dyeing orders that consume more resources with their more complex processing.

4.4 ABC implementation follow-up activities

The previous discussion shows that by implementing an ABC system considering multiple drivers in addition to the volume-based driver, the company can gain real insight into manufacturing expenses and have access to more accurate product cost information. However, just as in the case of companies in Cooper *et al.* (1992), the company did not implement the ABC system and merely elected to analyze it. Swenson (1995) argues that greater satisfaction with ABC systems leads to the utilization of ABC information to support decision-making or performance measurement. He also suggests studying ABC failure cases by examining the characteristics of companies and other factors that include the support or commitment of management. It is believed discussing the reasons why companies fail to implement ABC will benefit both academic research and business practice.

According to the past literature, the important factors that influence the successful implementation of ABC include:

- the possibility of cost distortion;
- the usefulness of cost information to decision-making;
- the linkage to competitive strategies and quality improvements;
- the support of senior management;
- the inclusion of educational training;

Table VI.
Attribution of product cost differences

Panel A: Attribution of product cost differences between the two costing systems

Cost difference (existing minus ABC)	*Production volume*	*Actual processing time*	*Rework cost*	*Dyeing auxiliary cost*
Overcosting	High	Short	Less	Less
Undercosting	Low	Long	More	More
Relation	Positive	Negative	Negative	Negative

Panel B: Correlation between cost differences and possible factors ($N = 1,309$ dyeing orders)

Pearson correlation	*Cost difference*	*Production volume*	*Actual processing time*	*Rework cost*	*Dyeing auxiliary cost*
Cost difference	1.000				
Production volume	0.076*	1.000			
Actual processing time	−0.363*	0.782*	1.000		
Rework cost	−0.114*	0.531*	0.701*	1.000	
Dyeing auxiliary cost	−0.805*	0.408*	0.730*	0.390*	1.000

Note: *Significance level is 0.01

- the linkage to performance evaluation and rewards; and
- the adequacy of resources (Foster and Swenson, 1997; Gosselin, 1997; Krumwiede, 1998; Shields, 1995; Shields and Young, 1989).

Now we will analyze whether or not the XYZ Textile Company in our study complies with the conditions just mentioned.

Possibility of cost distortion. Because of the great order variances and process complexity, the company has great cost distortion under the existing system. It would be desirable for the company to implement the ABC system.

Usefulness of cost information. The company fails to get sufficient and adequate information on product costs in order to make decisions under the existing system; implementing the ABC system would be helpful.

Linkage to competitive strategies and quality improvement. It is apparent that the ABC system is closely connected to the company's strategy of providing customer-tailored products in more varieties and smaller volumes, because ABC helps accurately calculate the costs of diversified products.

However, the company has faced different competitive pressures after the ABC experiment. Although cost control is still an important issue, differentiating its products from competitors seems more valuable to the company's future vision and profit. The company has focused on building brand and product innovation. Therefore, a change of external environment has led to a revision of strategy, and hence the priority of implementing ABC is lowered, which was not documented in previous ABC studies.

ABC facilitates measuring the rework costs of the company's dyeing orders, identifying factors such as the stages that require the rework and incur the heaviest costs, and is further relevant to quality improvement through Total Quality Management (TQM).

Support from senior management. Senior management actively supports and pushed for the implementation of ABC. But, as mentioned above, the revision of strategy has lowered the priority of ABC implementation.

On-the-job training and education. XYZ Textile Company not only released summarized ABC-related case studies, and literature through in-house periodicals, but also retained consultants and launched training programs for employees to obtain in-depth knowledge about the ABC system.

Linkage to performance evaluation and incentives. The incentive system at XYZ Textile Company is based partly on seniority. The company has been established for more than twenty years, and many employees have enjoyed a long tenure. If the company attempts to change the performance evaluation and incentives system to integrate the ABC system, most of the employees would oppose the initiative. On the other hand, if the company fails to connect ABC with its performance evaluation and incentives scheme, it cannot encourage employees to change their work habits to best support the ABC system.

Sufficient resources. Although the company has been equipped with ABC software, it lacks sufficient MIS staff to support the implementation of the ABC system. Moreover, it has assigned some of its staff to its plants overseas. Therefore, the company has failed to prepare interface programs to integrate ABC software and ERP.

Additionally, this study has also found that it is necessary for XYZ to improve its inventory management. The lack of accurate inventory data will bring a negative impact on ERP and create subsequent troubles for the ABC system.

Overall, in spite of:

- recognizing the necessity for ABC;
- garnering active support from senior management;
- having the involvement of consultants;
- possessing the requisite software; and
- providing educational training, the revision of XYZ's competitive strategy, lack of oversight in managerial controls (such as production and inventory management), inadequate linkage to performance evaluation and incentives, and failures in organization infrastructure (such as human resources), lead to the failure of ABC implementation.

5. Concluding remarks

In this paper, we report the results of an in-depth case study of a textile company in Taiwan. We examine the reasons for considering the implementation of ABC, the design and implementation process of an ABC system, the product cost differences under the existing costing and ABC systems, and the ultimate failure of ABC implementation. Our main findings are as follows:

- Although the company takes into account the degree of complexity and its cost relations in overhead allocation under the existing traditional volume-based cost system, the underlying faults in its design and application make it difficult to accurately allocate manufacturing overhead costs, and ultimately result in product cost distortion.
- Variations in manufacturing overhead costs can be more accurately explained by complexity-based drivers, such as production processes, product categories, rework rates, and resource utilization, in addition to volume-based drivers, such as finished products and equivalent production.
- The existing cost accounting system fails to consider the impact of rework on the product costs and the various requirements of individual dyeing orders, and thus results in cost distortions.
- The ABC system can estimate product costs more accurately because it uses both volume-based and non-volume-based (complexity) drivers. Additionally, it takes the impacts of costs from reworking on the products into account.
- Compared to the ABC model with one sample month of data, the existing volume-based cost accounting system overestimates the costs of products with higher volumes and underestimates the costs of products with higher complexity.
- The company focused on the analysis stage of ABC implementation and did not move to the action stage in which it would make use of ABC information for various decisions. The company did meet some criteria for successful ABC implementation, such as recognizing the necessity for introducing ABC, having the support of senior management, being equipped with software, and providing training and education. However, there are some other factors that prevent the company from successfully implementing ABC, such as lack of linkage to performance evaluation and incentives, an insufficient amount of MIS staff, and inadequate inventory management. Moreover, to implement ABC properly, considerable raw data needs

to be collected and examined for accuracy, and this work requires both proper MIS skills and the cooperation from inventory management. Also, XYZ management focused more on brand, productivity, and innovation, and did not consider amending the performance scheme related to ABC implementation, and this resulted in postponing the implementation of the ABC system.

This study extends prior research in the following directions. First, our research reports the entire process of ABC implementation for a given company, while most previous studies tend to focus on only one part of the process. For example, we not only examine the relationship between volume-based drivers (as opposed to complexity-based drivers) and overhead costs, but also validate the ABC system. In addition, prior studies use survey or interview data to investigate the success factors in implementing ABC without reporting the features of the existing cost systems. Integrating these issues in a single study facilitates a more complete understanding of ABC design and implementation. Second, while most prior research tends to focus on success cases, our study presents a failure case, which has implications for practitioners trying to avoid the same mistakes. Among our findings, it is worthwhile to note that the company in our study has inadequate production management and inventory controls, and that the company amended its business strategy when facing a change in external conditions, which is something not found in prior ABC research. Nevertheless, such a finding suggests a new dimension of ABC research related to integrating production and operation management with product costing systems.

Note

1. Since direct labor cost constitutes only 2.7 percent of production costs, they are allocated in a same manner as indirect labor costs.

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(The Appendix Tables follow overleaf.)

Appendix 1

7XY244	Allocation basis	Allocation proportion	Cost (new Taiwan dollars)[a]
Existing costing system	Production yards × conversion coefficient (125 × 2.6)	0.000004	$226
ABC	Regular dyeing order job cost		$3,733.93
	Inspection section	0.000274	2.33%
	Control section	0.000491	0.77%
	Production control section	0.000475	2.91%
	Dyeing department administration	0.000491	4.91%
	Purchasing and warehousing section	0.000491	0.86%
	QC personnel	0.000940	5.46%
	Shade	0.000034	0.14%
	Full piece cloth inspection	0.000036	1.32%
	PE plastic film packing	0.000031	0.39%
	Box packaging	0.000031	0.52%
	Dyeing facilities and dyestuff	0.000006	1.16%
	709 Dyeing auxiliaries	0.000234	0.81%
	818 Dyeing auxiliaries	0.000553	2.16%
	891 Dyeing auxiliaries	0.000088	0.98%
	901 Dyeing auxiliaries	0.000115	0.56%
	906 Dyeing auxiliaries	0.000306	0.14%
	909 Dyeing auxiliaries	0.019656	61.52%
	Dyeing	0.000070	13.05%
	Rework costs		$1,587.36
	Control section	0.000491	1.8%
	Production control section	0.000491	6.84%
	Dying department administration	0.000491	11.54%
	Purchasing and warehousing section	0.000491	2.03%
	864 Dyeing auxiliaries	0.000146	1.38%
	866 Dyeing auxiliaries	0.000093	0.43%
	Dyeing	0.000158	69.51%
	Cloth-expanding drying	0.000129	3.02%
	Finished goods molding	0.000075	3.45%

Notes: The allocation proportion under the existing costing system refers to the percentage of allocated costs in proportion to the total processing costs. The allocation proportion under the ABC system refers to the percentage of allocated activity driver quantities in proportion to the total activity driver quantities. The column to the right of the allocation proportion with respect to the ABC system represents the percentage of cost amounts, which constitute the total cost of the dyeing order job. [a]The data may be subject to adjustment to maintain confidentiality, but the existing relations are maintained

Table AI.
Example of an under-estimated dyeing order

Appendix 2

7XY570	Allocation base	Allocation proportion	Cost (new Taiwan dollars)[a]
Existing costing system	Production yards × conversion coefficient (1283 × 2.2)	0.000364	$1,967
ABC	Regular dyeing order job cost		$10,559.91
	Inspection section	0.000091	0.27%
	Control section	0.000491	0.27%
	Production control section	0.000491	1.03%
	Dyeing department administration	0.000491	1.74%
	Purchasing and warehousing section	0.000491	0.31%
	QC personnel	0.000940	1.93%
	Shade	0.000160	0.23%
	Full Piece cloth inspection	0.000171	2.19%
	PE plastic film packing	0.000088	0.39%
	Box packaging	0.000088	0.51%
	Dyeing facilities and dyestuff	0.000236	16.49%
	709 Dyeing auxiliaries	0.001169	0.14%
	818 Dyeing auxiliaries	0.022883	0.38%
	891 Dyeing auxiliaries	0.000219	0.86%
	901 Dyeing auxiliaries	0.000411	0.5%
	902 Dyeing auxiliaries	0.021298	2.44%
	903 Dyeing auxiliaries	0.016280	2.41%
	Cloth carrying	0.000130	0.56%
	Dyeing	0.000991	65.31%
	Cloth-expanding drying	0.000063	0.79%
	Colonel molding	0.000458	1.23%
	Rework costs		$1,017.06
	Control section	0.000491	2.81%
	Production control section	0.000491	10.67%
	Dyeing department administration	0.000491	18.02%
	Purchasing & warehousing section	0.000491	3.17%
	Dyeing	0.000086	58.54%
	Cloth-expanding drying	0.000021	2.75%
	Colonel molding	0.000145	4.04%

Note: [a]The data may be subject to adjustment to maintain confidentiality, but the existing relations are maintained

Table AII. Example of an under-estimated dyeing order

Appendix 3

7XT055	Allocation base	Allocation proportion	Costs (new Taiwan dollars) [a]
Existing costing system	Production yards × conversion coefficient (20151 × 5.7)	0.014877	$80,356.50
ABC	Regular dyeing order job costs		$40,399.97
	Control section	0.000491	0.07%
	Production control section	0.000491	0.27%
	Dyeing department administration	0.000491	0.45%
	Purchasing and warehousing section	0.000491	0.08%
	QC personnel	0.000940	0.5%
	Shade	0.002300	0.87%
	Full piece cloth inspection	0.002443	8.22%
	PE plastic film packaging	0.001409	1.61%
	Box packaging	0.001409	2.13%
	709 Dyeing auxiliaries	0.001800	0.58%
	812 Dyeing auxiliaries	0.022585	0.45%
	906 Dyeing auxiliaries	0.002359	0.1%
	Cloth-carrying	0.002143	2.41%
	Starch-removing	0.004627	12.29%
	Ruffling	0.003305	11.04%
	Untwisting	0.001852	12.64%
	Cloth-expanding drying	0.002217	7.29%
	Preliminary molding	0.002362	6.32%
	Molding	0.003667	8.54%
	Nap-abrading	0.004154	24.13%
	Rework costs		$1,576.50
	Control section	0.000491	1.81%
	Production control section	0.000491	6.88%
	Dyeing department administration	0.000491	11.62%
	Purchasing and warehousing section	0.000491	2.05%
	Cloth-expanding drying	0.000045	3.8%
	Preliminary molding	0.000184	12.59%
	Molding	0.000270	16.06%
	Nap-abrading	0.000304	45.19%

Note: [a]The data may be subject to adjustment to maintain confidentiality, but the existing relations are maintained

Table AIII. Example of an under-estimated dyeing order

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