Total Cost of Ownership: Elements and Implementation

By Lisa Ellram

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While total cost of ownership concepts are widely discussed, in practice most firms do not utilize the total cost concept in purchasing. This article uses findings from studies of nine firms that use total cost of ownership to define the total cost of ownership concept and benefits. A framework for classifying cost elements is developed. The article concludes with a discussion of key total cost of ownership implementation issues, and explores two approaches to implementation of total cost of ownership concepts in purchasing.

INTRODUCTION

For years, purchasing departments in many companies have talked about purchasing based on “total cost” rather than just price. Unfortunately, few companies have the information or the reporting systems readily available to them to support such a goal. “Total cost of ownership” (TCO) is a phrase used to describe “all costs associated with the acquisition, use, and maintenance” of a good or service. Like the total cost concept in logistics, the total cost of ownership examines the cost associated with purchased goods and services throughout the entire supply chain. Thus, TCO considers costs all the way from idea inception, as in working with a supplier to develop a new or improved part, through warranty claims associated with that part once the final product is in use by the customer.

This article provides background information about key TCO concepts. It defines TCO and, based on case studies of nine firms that use TCO approaches, it discusses the benefits of using the TCO approach. To facilitate the understanding

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of TCO concepts, a framework is developed that divides purchasing related costs into pretransaction, transaction, and postransaction elements. In addition, the article describes two general approaches for implementing the TCO concept, discussing both the benefits and disadvantages of each approach.

TOTAL COST OF OWNERSHIP IS DIFFERENT FROM MOST APPROACHES

TCO differs in two important ways from most models that attempt to look at the "cost" of doing business with a supplier. First, TCO considers a broader spectrum of acquisition costs than do most cost of ownership systems. Second, TCO attempts to look at life cycle costs, which consider costs associated with using a given item from a given supplier during the entire life of the item, including costs incurred once the item is in use.

For example, for capital equipment, postpurchase costs involve everything form maintenance, repairs, downtime, and obsolescence through to the ultimate disposal of the asset. For a component or material, total cost includes failure costs of the item once in use, such as warranty claim costs, lost goodwill, replacement, and similar costs. TCO issues associated with both of these types of purchases are expanded in the following sections.

TCO BENEFITS

TCO is a relatively complex method for developing an understanding of the true cost of a purchase. Yet, the firms studied in this research all believe that the benefits of TCO outweigh the major barrier to TCO implementation and execution—namely, the lack of readily available data to support TCO operation.

Major TCO benefits cited by the firms studied are shown in Table I. For convenience in discussing these benefits, they are grouped into five categories: benefits associated with (1) performance measurement, (2) decision making, (3) communication, (4) insight/understanding, and (5) the support of continuous improvement efforts. Although a benefit may fit into more than one category, for ease of discussion each benefit is considered in light of its most important role.

The "performance measurement" category of benefits includes those that improve the quantitative measurement of supplier performance. It includes such issues as the following: TCO is a good way to evaluate suppliers; TCO provides a quantitative method for measuring the results of supplier performance improvement/quality improvement efforts; and TCO provides an excellent tool for benchmarking. In benchmarking, TCO data can be used to compare suppliers, or to track changes in a supplier's cost performance over time.

TCO also supports improved decision making. TCO forces the quantification of tradeoffs in terms of dollars. It also provides a good basis for supplier selection decisions, because it provides complete cost data on the important cost issues. Thus, TCO creates more informed decision making, in a structured, systematic way.

TCO can also help improve both internal and external communications for the purchasing function. The system provides solid data to communicate to suppliers regarding their performance. It also represents an important way to get others within the firm involved in purchasing decisions—by providing data, or identifying relevant cost considerations.

The depth of the TCO approach also provides important insights and deeper understanding into the true nature of
supplier performance. The information developed using TCO regarding a supplier’s total costs can be used to track the supplier’s costs over time, or to compare with other suppliers. Such detailed information provides excellent data for negotiations, and can help focus target pricing efforts. TCO also helps purchasing personnel develop an awareness of the significant nonprice factors that affect their firm in the case of certain buys. This insight can help in negotiations, and in determining which nonprice cost elements a supplier should provide, and which can be foregone or obtained more economically elsewhere. Finally, TCO provides a better understanding of purchase decisions by taking a long-term, big picture approach. It looks beyond price to explore how purchasing activity affects the firm’s total costs both today and in the future.

All of these categories of benefits represent proactive means for purchasing to help continuously improve some aspect of the firm’s or the supplier’s operations. The last major benefit category includes those benefits specifically aimed at supporting a firm’s continuous improvement efforts. By identifying various critical cost elements and their values, TCO helps focus a supplier’s efforts on improving the “right thing.” TCO also uncovers cost savings opportunities by highlighting large cost elements. Internally, TCO allows firms to gain an understanding of how their requirements (delivery, inventory, unique specifications, and so on) may actually increase costs of ownership. It may be prudent to modify such requirements. Finally, TCO represents a method for the purchasing function to support the firm’s overall continuous improvement efforts by broadening the perspective of purchasing personnel, and improving purchasing’s decision-making process.3

**CURRENT TCO PRACTICES**

Recent studies indicate that the total cost of ownership concept is not widely understood or utilized in the purchasing function today. A 1991 survey of National Association of Purchasing Management (NAPM) members indicated that 85 percent of the respondents were familiar with the TCO approach. Further, 69 percent said they would be comfortable either using or interpreting the results from a TCO model.3

To provide further insight, a group of purchasing managers attending a cost savings workshop at NAPM’s 1991 Annual International Conference was studied to determine the degree of utilization of the TCO concept. Because of the group’s interest in purchasing cost savings and analysis, it was assumed that those responding to this survey would be more progressive in the costing approaches than would the average purchasing manager.

One hundred three managers participated in the study, the results of which are shown in Table II. Ironically, only 18 percent use a formalized TCO approach for evaluating purchases. Fifty-eight percent indicated that they use a TCO approach on an informal basis, and 24 percent indicated that they make no attempt to use TCO in analyzing purchases.

<table>
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<tr>
<th>Table II</th>
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<tbody>
<tr>
<td>NAPM COST SAVINGS WORKSHOP SURVEY: Respondents Whose Companies Use TCO in Evaluating Purchases</td>
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<tr>
<td>Response</td>
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<tr>
<td>Unsure</td>
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<td>Yes, Formal Model</td>
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<td>Yes, Informal Model</td>
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<tr>
<td>No</td>
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<td><strong>Total</strong></td>
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N=103

An informal TCO approach represents a method in which cost factors beyond price, such as the cost of rejected materials, are informally considered in supplier selection and evaluation. For example, a buyer might be aware that one supplier produces frequent invoicing discrepancies. The time and effort spent correcting these problems increases the cost of doing business with that supplier. While unaware of how much such error correction costs the firm, the buyer makes a mental note of it. Thus, while such factors have an impact on the firm’s perception of the supplier, those factors are not specifically “added in” and accounted for as a cost of buying a particular item or service from a particular supplier.

On the other hand, a formal TCO approach explicitly recognizes cost factors in addition to price as part of the cost of doing business with a particular supplier. The number of cost factors considered, the manner in which the data are gathered, the types of cost factors, and the precision of the costs vary greatly from firm to firm. At a minimum, any TCO approach should include transportation costs, receiving costs, quality costs (inspection, rework, reject costs), purchasing administrative expenses, including management time, and of course, the price of the purchased item. In practice, some firms do leave out one or more of these costs, often the administrative costs.

A review of the TCO literature indicates that costs such as quality and delivery are the most commonly included items in total cost of ownership models. Service costs frequently are included as well. Service costs vary widely in nature, but typically include costs associated with issues such as whether the firm has a compatible EDI system, the cost of delays while working with the supplier to rectify a problem, and similar items.3

The “traditional” supplier selection model that is closest to the TCO approach is the cost ratio approach. In general, the cost ratio approach considers the costs the firm incurs internally that are associated with quality, delivery, and service. Thus, like most models firms use under the name of
total cost analysis, cost ratio models are more limited in the scope of costs considered than a true TCO approach. The breadth of costs considered by TCO is discussed further in the following sections.

**COST ONCE A PRODUCT IS IN USE**

Many firms that use a TCO approach are excellent at accounting for costs that occur prior to and during the purchase of a good or service. These firms usually have a good grasp of how much time, effort, and expense is involved in adding suppliers to their systems and in placing orders. They know the value to their firm of on-time delivery, how much it costs to follow up on problems, match receiving with invoices, and even cut checks. However, once the item or service is consumed, these firms often lose track of the costs associated with the purchase. Thus, the area in which most TCO models in use today fall short of the spirit of a true TCO model is in the analysis of costs associated with an item once it is in use. As mentioned earlier, there are a number of costs that should be considered once a product is in service. Because these costs are often significant, and vary greatly by type of buy, they are discussed separately in the following paragraphs.

Component Parts and Materials

Once a component or a material is consumed in the manufacturing process and becomes part of the end product or service, the purchasing function traditionally has become detached from further analysis. Costs associated with the failure of a component or material once in possession of the customer are rarely tracked and communicated to the purchasing function. Yet such costs, which are frequently incurred after the product or service has left the company, should be very relevant to the supplier selection, evaluation, and retention process. Indeed, an understanding of such costs is critical in providing the best value not only to the producing firm but also to the customer, the ultimate judge of the firm’s value.

Experience has shown that it costs a great deal to develop a customer. A recent study indicates that improving customer retention by 2 percent produces the same profit impact as reducing costs by 10 percent. Thus, the loss of a customer or customer goodwill because of faulty inputs can be costly to the firm as a whole. Taking an integrated, systems approach to purchasing, the impact of purchasing’s supplier selection and management decision can be very relevant to the customer service provided by the firm as a whole.

Capital Goods

In most cases, the price of a capital item is only a small part of the total cost of the item over its lifetime use.

*Production equipment* is a good example. A model used by one of the firms studied indicates that the price of a piece of production equipment for the firm’s operations is around 35 percent of the total cost of that piece of equipment over its life cycle. For this firm, and many other manufacturing firms, costs incurred after the asset is in use account for 50 percent or more of the TCO. These costs are often termed “life cycle” costs, because they are incurred throughout the life of a piece of equipment, as that equipment is used. Critical costs that need to be considered in the total cost of ownership for production equipment include costs such as yield loss of production materials, maintenance costs, downtime, repair and overhead costs, and idle time costs for staff. Thus, there are many longer term cost factors beyond the initial price of the equipment.

*Operating capital* includes items such as personal computers, cars, copy machines, and similar items. Some of the costs associated with operating capital once in use include maintenance, replacement services when equipment is down, lost staff time, and lost goodwill. There is a great deal of overlap between the nature of costs included in the “costs once in use” portion of TCO for production capital and operating capital items.

Maintenance, Repair, and Operating Supply Items (MRO)

Some of the largest costs many firms associate with MRO items are cost of failure and associated replacement costs when in use. However, MRO items tend to be the “80 percent of the items” that make up “only 20 percent of the dollar value of purchases.” Thus, because MRO items are very transaction intensive relative to their price, in some cases a true total cost perspective may reveal that the lowest TCO comes from maintaining inventory. Consequently, a TCO approach must weigh the costs of maintaining inventory, and potential obsolescence risks, with the potential downtime and other inconvenience costs associated with not stocking an MRO item.

Some firms delegate to a third party distributor the management of their MRO items. In such cases, the buyer usually pays the third party more “out of pocket” than if the items were purchased directly from individual MRO suppliers. However, such a system may cost less in terms of the total cost of ownership by utilizing the distributor’s expertise, volume buying leverage, and improved emergency responsiveness, and by reducing internal costs through paperwork reduction, error reduction, and lower inventories.

Services

It is usually more difficult to pinpoint costs incurred after a service has been performed because of the intangible nature of the service. Some of the issues are also intangible; for example, does the service performed meet the user’s needs and leave the user feeling “satisfied”? More tangible issues that should be part of the TCO for services include items such as the user’s need to have follow-up or rework done because of incomplete or unsatisfactory service performance, costs of service agreements, and costs of services performed outside of service agreements.
A FRAMEWORK FOR UNDERSTANDING TOTAL COST OF OWNERSHIP

In an earlier study, the researchers suggest a model for understanding the total cost of ownership that groups purchasing activities into six categories: (1) quality, (2) management, (3) delivery, (4) service, (5) communications, and (6) price. Another logical way to view the costs of ownership is based on the order in which the cost elements are incurred, that is as they relate to the transaction sequence: pretransaction, transaction, and posttransaction. These latter categories, which are based on a customer service model developed by LaLonde and Zinzer, have been adapted to fit the TCO concept.

Pretransaction Costs
As indicated in Figure 1, pretransaction costs are those costs that occur prior to receiving the purchased items, and even prior to placing the order. Pretransaction costs include all costs incurred from the time that anyone within the firm begins to think about and investigate the possibility of buying an item, up to, but not including, order placement.

Some of the costs that may be overlooked are the costs of investigating alternative sources, qualifying and educating suppliers regarding the firm’s systems and expectations, and adapting to the systems, styles, and delivery methods of new sources of supply. As one of the firms studied pointed out, “Buyers will do anything to reduce price. They tend to forget how costly it is to add a new supplier to our system, increase the number of checks cut, prequalify the supplier, and so on.” Because these costs are often not accounted for based on the transaction that created the costs, such costs are frequently overlooked. Thus, supplier selection and the addition of new suppliers is considered to be “free,” when that clearly is not the case.

Transaction Costs
Transaction cost elements are those items that are related to order placement and receipt, and include the price of the item or service itself, as shown in Figure 1. Included are those costs associated with actually placing an order and getting the order in to the firm or supply chain, ready for the next value-added process. As such, transaction costs are those costs associated with preparing and placing the order (EDI, Fax, phone, and so on), following up on the order, receiving, matching receiving data to the invoice, and paying the bill.

Transaction cost elements tend to be more widely recognized than pretransaction and posttransaction costs, because these are the costs that occur in closest time, space, and relationship with the transaction itself. Costs that are sometimes overlooked in compiling transaction costs are purchase order preparation, auditing and matching of order, receiving and invoice payment, and correction of incorrect documents.

<table>
<thead>
<tr>
<th>TOTAL COST OF OWNERSHIP</th>
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<tr>
<td>1. Pretransaction Components</td>
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<td>2. Transaction Components</td>
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<tr>
<td>3. Posttransaction Components</td>
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Pretransaction Components
1. Identifying need
2. Investigating sources
3. Qualifying sources
4. Adding supplier to internal systems
5. Educating:
   - supplier in firm’s operations
   - firm in supplier’s operations

Transaction Components
1. Price
2. Order placement/preparation
3. Delivery/transportation
4. Tariffs/duties
5. Billing/payment
6. Inspection
7. Return of parts
8. Follow-up and correction

Posttransaction Components
1. Line fallout
2. Defective finished goods rejected before sale
3. Field failures
4. Repair/replacement in field
5. Customer goodwill/reputation of firm
6. Cost of repair parts
7. Cost of maintenance and repairs

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routine and special maintenance costs, costs associated with replacement part scarcity and/or obsolescence, and similar issues. These costs are often difficult to track, and may be separated form the purchase by a great deal of time.

For component parts, a firm is more likely to associate posttransaction costs with a particular buy if they occur soon after the transaction. Such costs may include line fallout, part failure in finished goods testing, and field failure that occurs soon after the sale. For capital equipment, posttransaction costs such as equipment downtime, repair, and maintenance typically are recognized as being associated with a particular piece of equipment. However, rarely does a firm that does not use a TCO approach account for those costs separately and go back and review the capital acquisition decision from a TCO perspective.

### Development of a Process Flow Chart

Before beginning the implementation of a TCO approach, it is critical for a firm to have an understanding of its major costs of ownership. To help identify these costs, the firm can use the transaction cost framework just discussed to identify the total costs of ownership for each purchase category (components/materials, MRO, capital for production, capital for support, and services) management is interested in exploring. While individual items within each category may vary slightly with respect to relevant cost elements, the development of such a flow chart can provide a great deal of insight into the potential issues affecting each category.

A proposed format for such a process flow chart is shown in Figure 2. It includes several examples of the types of costs that could fit into each major category. While

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<tr>
<th>FLOW CHART OF MAJOR PURCHASING COST ELEMENTS</th>
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<tr>
<td><strong>Activity Related to the Purchasing Process</strong></td>
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<tr>
<td>PRETRANSACTION</td>
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<tr>
<td>Need for new production equipment identified</td>
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<tr>
<td>TRANSACTION</td>
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<tr>
<td>Equipment Purchased</td>
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<td>Equipment Installation</td>
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<td>POSTTRANSACTION</td>
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<td>Routine Maintenance</td>
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<td>Repairs</td>
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Note: This figure illustrates several examples of the types of costs a firm may incur when purchasing capital equipment for production. The costs are not meant to be inclusive.

* The activity performed is a process that creates costs. The goal is to understand what costs may be created.

** Potential cost elements represent the major activities in each process that may create costs.

*** Cost drivers represent the way in which potential cost elements break down into individual costs which make up the total cost for that activity.
purchasing can begin constructing the chart based on its knowledge of the transaction flow, it is advisable to get input from other functions that are directly affected by incoming purchases. This may include input from accounting, engineering, quality, and other functional areas.

TOTAL COST OF OWNERSHIP IMPLEMENTATION

The preceding discussion of the potential elements that make up the total cost ownership for a given purchase from a given supplier is by no means comprehensive in nature. The myriad of issues and costs that may impact the TCO for an item is almost endless. Given that most firms do not have detailed cost data readily available, nor do they have systems for monitoring and tracking TCO, a simplified approach to total cost of ownership analysis is essential to make TCO workable, without becoming overwhelming. Detailed suggestions for refining the data gathering process to support TCO can be found in the author’s earlier study.

There are several approaches a firm can take in implementing a TCO philosophy. First and foremost, the organization must move away from solely a price orientation, to grasp the idea that “total cost” may be much more important than price. To experienced TCO users, this may seem like an easy task. However, for a firm that has been operating in a highly price competitive market, focusing on supplier price reduction, TCO may be a very difficult concept to sell to others within the firm. Indeed, one of the firms studied found that in using the TCO approach, it had to avoid use of the term “cost.” Cost immediately drove the firm’s buyers to look at price, which is often the largest TCO cost element. Instead, they chose to use the term “value.”

Implementation Issues

The development and implementation of a TCO approach in purchasing will likely be a major undertaking for a firm for a variety of reasons. The first critical issue, as mentioned above, is that the firm must move away from a price orientation to a TCO philosophy. Purchasing may have to demonstrate that a TCO philosophy is a superior way to manage and understand costs. The proof may have to come through a successful TCO pilot operation.

Second, few firms have accurate cost information for the pretransaction, transaction, and posttransaction cost components. Even fewer firms have this detail data at an item level. Thus, significant effort may have to be devoted to:

1. Develop a process flow chart, as discussed, to sharpen the focus on the firm’s pretransaction, transaction, and posttransaction cost elements.
2. Determine which cost components are significant enough to warrant tracking. Use Pareto’s Law coupled with common sense. There are probably a few key cost components that make up the majority of TCO expenses for a given item.
3. Determine how these significant cost components will be tracked.
4. Gather and summarize the relevant cost component data.
5. Analyze the results.

For most firms, data gathering will begin as a significant manual effort.

Third, the firm needs to determine where to begin its TCO efforts. Should it begin with one item, a family of items, items that fit into different buying categories—such as a component, a capital equipment item, and so on? This decision is very individual by firm, depending on the industry and the firm’s overall and TCO philosophies. This third issue is discussed more fully in the next section.

Fourth, a firm must begin to think about how and where TCO will be used. Will it be a tool reserved for critical items, or will it be more broadly used? Will TCO be used to select suppliers, manage costs with current suppliers, or allocate purchases among suppliers? Will one TCO model be used to provide the data to support all those efforts? The proposed scope will have an impact on the way in which a TCO approach is implemented.

There are two basic TCO implementation approaches. The first, a TCO pilot study, is based on the selection of one or a handful of items to begin with. A TCO approach for the firm is then developed, based on actual experience with the pilot items. The second approach involves a “full” implementation, where the TCO model is basically implemented simultaneously for all items that will use the TCO philosophy. Both approaches are discussed below.

Pilot Study

A pilot study is based on the premise that a wise approach to use in implementing an untried concept is to focus on a small, easily controlled group of items. Eight of the nine firms studied followed this approach. TCO may begin with one item—it may be a component, regularly purchased capital item, regularly purchased service, MRO item, or something similar. It would be ideal to pick an item that meets the characteristics in Table III (see p. 10); however, this may not be possible. If there is no item available that meets all the characteristics in Table III, one should be chosen with as many of those characteristics as possible.

The characteristics in Table III are suggested because an item that meets those characteristics has a high probability of creating a successful first project. Such an item may illustrate that the TCO is indeed much higher than the price. Because an item with some individually large transactions costs that the firm can affect is chosen, purchasing and/or other functional areas may be in a position to reduce costs significantly based on the TCO analysis data. In addition, gathering information about TCO, others in the firm must be involved. If other functional personnel develop an interest, there will be more support for gathering and analyzing the TCO information. Others in the firm may have insight into bottleneck or problem areas associated with an item that purchasing is unaware of.

The benefits of beginning with a pilot study are summarized in Table IV (see p. 10). The pilot study can be a valuable learning experience to help ensure that the subsequent expansion of TCO flows more smoothly. Further, a pilot
The firm did have some problems with implementation—data were not readily available, there were delays in reporting, and so on. But with top management support, these pitfalls were overcome. A year later, although the TCO model is still evolving to some extent, this firm has an excellent model in place. The model is used throughout the firm for guiding the buying and management of key purchased components and materials for manufacturing.

### Table V

**BENEFITS OF FULL TCO IMPLEMENTATION**

- Widespread results throughout the firm
- Fast benefits
- Fast development of TCO understanding
- TCO gets attention—requires focused commitment

### CONCLUSIONS

TCO represents an important means for the purchasing function to add value to the firm. It is more than a tool. TCO is a philosophy that guides purchasing in the supplier selection decision as well as in supplier evaluation, negotiation, and volume allocation among suppliers.

Relatively few firms in the United States have implemented a formal TCO approach. Yet the number is growing, as firms continue to recognize that price is not the all-important supplier selection criterion. Firms interested in implementing a TCO approach must first develop an understanding of the specific costs that are important in their firm. One way to do this is to develop a process flow chart that tracks a purchased item through the entire supply chain—from pretransaction (order placement), to transaction (order receipt), to posttransaction (subsequent use and disposition). This activity in itself can provide some very useful, insightful information. A process flow chart, such as the one shown in Figure 2, can help identify the major cost elements in addition to price, and provide focus and direction in developing and implementing a TCO approach.

This step, however, is only the beginning. Many decisions associated with the TCO implementation process must be made—from deciding whether to have a pilot study to deciding which items should be included in the formalized TCO approach. While TCO requires a major implementation effort, it clearly produces major benefits for the firm. As pointed out by the firms studied, TCO supports better supplier performance measurement, improved decision making in supplier selection and related areas, better internal and external communications for the purchasing function, greater insight and understanding of cost issues related to purchasing, as well as a firm's continuous improvement efforts.

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**Table III**

**CHARACTERISTICS OF AN ITEM FOR PILOT TCO PROJECT**

- The firm spends a relatively large amount of money on that item.
- The firm purchases the item with some degree of regularity, in order to provide some historical data, but more important, to allow opportunities to gather current cost data.
- Purchasing believes the item has significant transaction costs associated with it that are not currently recognized.
- Purchasing believes that one or more of the currently unrecognized transaction costs is individually significant.
- Purchasing has the opportunity to have an impact on transactions costs, via negotiation, changing suppliers, or improving internal operations.
- Those purchasing or using the item will cooperate in data gathering to learn more about the item's cost structure.

**Table IV**

**BENEFITS OF TCO PILOT STUDY**

- Gain understanding of data sources/unavailability
- Experiment with alternative TCO models (e.g., standard vs. flexible cost components in all models)
- Educate others in the firm regarding TCO
- Improve cooperation within the firm by getting others to participate
- Convince people in the firm of the benefits of TCO by demonstration
- Become familiar with the TCO model and possible pitfalls

Full Implementation

Some firms have decided to skip the pilot TCO implementation and its associated learning, and forge right into implementing their “vision” of a TCO model. Firms may choose to do this when they have full top management support or when they believe the need for a TCO approach is urgent. In addition, they may feel very comfortable and confident that they understand the TCO approach and how they would like to develop it within the firm.

Among the firms studied, only one took this approach. Some members of the purchasing function had been using an “informal” TCO approach prior to implementing the formalized approach. This firm implemented TCO without a pilot when a new chief financial officer was appointed. This individual was convinced that TCO was a superior supplier management tool. The benefits of full TCO implementation are shown in Table V.
Future research should continue to explore TCO implementation issues. Further, since one of the primary issues that creates difficulty in TCO implementation is the lack of TCO data, it would be beneficial to direct some research effort toward the development of improved data gathering approaches.

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