

Getting What You Pay For? - Total Cost of Ownership Model

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Abstract. “Are you getting what you pay for?” This Total Cost of Ownership model calculates the multiple variables that determine total cost. By using the tool when sourcing a requirement, the supply professional takes steps to mitigate risks that translate into increased cost. The tool applies weighted values to such elements as price, logistics, quality, risk, maintenance and repairs, and administrative and financing factors to determine a “total cost” for the requirement. The tool provides a format to calculate the factors used in a Total Cost of Ownership decision. The weighted cost factors consider the importance and degree of risk involved in the purchase. Individuals should understand their own organization’s needs to define the amount of weight (risk) assigned to each variable. This model is also intended to inspire thought on how your organization can add/subtract elements to determine your own Total Cost of Ownership model.

Introduction. For the Supply Chain profession, today’s roles and expectations are different when compared to past years. In the past, Purchasing personnel performed a relatively clerical role in an organization. Sourcing decisions were made by comparing not much more than the “unit price” of the required product or service. As long as the lowest price was chosen, Purchasing was considered doing its job to “cut” the cost of the requirement.

Today, the Supply professional has evolved from a reactive and/or transactional function to managing a strategic supply chain. The focus for sourcing decisions broadened based on elements of Total Cost of Ownership. These elements include managing the logistical aspects of procurement, maintaining inventory levels, assuring quality product, and mitigating the risks associated with doing business with other organizations. Each of these elements has costs associated with it. Accumulating all of these costs provides a new method for supply managers to make sourcing decisions. By adding the costs of all elements associated with the procurement in a model, the “Total Cost of Ownership” (TCO) is then more closely defined.

The Total Cost of Ownership model discussed in this paper sets the stage to use a TCO tool, the elements of this tool, the definition and reasoning of the TCO elements, and how total cost relates to lean principles.

Setting the Stage. Success in today’s market depends on how quickly an organization can meet the ever-changing customer requirements. The analysis of the customer requirements provides the basis for determining the cost drivers associated with purchasing the product or service. According to Dobler and Burt in Purchasing and Supply Management, management has the right to expect product and services of the “right quality, from the right supplier, in the right quantity, at the right time, and at the right price.” Getting the supply chain to produce

these expectations, involves an analysis of the total cost – since the total cost is what results from meeting these expectations.

How does the supply professional define what the expectations are? Or, in other words, “what is of value?” In today’s lean manufacturing environment, value is defined by the customer. That is, what is the customer willing to pay for? The ever-changing customer requirement is exactly where expectations are defined. Proactive communication between various departments is required to understand and define what is valuable to the customer. The supply professional cannot guess or assume what the customer thinks; but rather, must learn and then execute to fully meet customer requirements.

Next, a value stream mapping exercise (a lean principle) is used to determine all of the steps from customer order to fulfillment. Value stream mapping is the identification of every action required to take an idea from concept to fulfillment of customer order. Mapping the value stream in the supply chain in addition to the value stream in the manufacturing process identifies the cost drivers to deliver product or services. Both physical and informational value streams are mapped to determine what elements are involved. When this mapping process includes information about the country of origin, the cost factors associated with the product sourcing may also be identified.

Remembering that price is simply the stated amount for the actual product; from the value stream, the supply professional determines the cost drivers and then the costs of each of these drivers may be identified. By reviewing the value stream against what the customer finds of value and is willing to pay for, the wasteful activity is exposed. The supply manager and the supplier candidates can work together to eliminate the non-value added activity.

Adding outsourcing decisions (domestic and/or international) reduces the simplicity of providing a product or service for your internal and external customers. No longer are products produced in your four walls. With outsourcing, other factors including annual usage, unit price, quality, lead-time, inventory levels, packaging, transportation modes, customs and duties, supplier validation, and financial terms are some of the necessary considerations. This TCO tool provides the mechanism to measure the comparative cost of potential value streams. Through analysis of these specific costs, the supply professional as well as other “decision makers” can see and compare the financial impact of multiple sources of product.

Elements of the Total Cost of Ownership Model. The TCO model examines soft costs as well as the obvious costs of doing business. Starting with the selection of the areas of origin (this model features these regions: *(your requirements may be different)* United States, China, India, Mexico, South America, and Eastern Europe). Specific required inputs necessary for the model to operate as intended include those shown in Figure 1.

Required Inputs

Annual Usage Unit weight per part (lbs) Unit Price (USD\$) Shipments per year Tooling Costs Is Tool Maintenance included in PPC (Y/N) Are you Shipping Ocean/Surface (Y/N) Incoming IQA Required (Y/N) CpK Capability	Is this a new Supplier (Y/N) Discount Payment Terms (%) Net Payment Terms (days) Enter Days of Inventory on hand Is this Supplier unionized (Y/N) What is the Stacked Lead-time Delivery Performance (Historical %) Percent of Expedited Orders Committed to sign or have existing Legal Supply Agreements (Y/N)
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Figure 1. Required Inputs

These required inputs represent the specific information about the supplier candidates and product requirement for which the sourcing decision is being made. In addition to these required inputs, other variables used in the model include those shown below in Figure 2.

Cost Variables

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Figure 2. Cost Variables

The model links these variables with specific data based on the area of origin. By connecting the inputs to these factors, the TCO model automatically calculates the multiple variables that determine total cost. By factoring the identified pertinent risks, the supply manager can determine where the best value is for the stated requirement.

Definition and Reasoning Behind the Cost Variables. The TCO model utilizes five primary elements besides unit price to assist in defining the Total Cost of Ownership. These elements are (1.) Logistics; (2.) Quality Assurance; (3.) Risk; (4.) Maintenance and Repair; and (5.) Administrative and Financing. Within these five elements are characterizing subcategories that when utilized “fine tune” the Total Cost of Ownership model. Each element’s subcategories are then “weighted” based upon the experiences incurred by the company(ies) which use(s) this model.

Logistics: The supply chain professional typically uses this obvious element for determining the cost to procure a product or service. However, there are other considerations to be factored besides the freight bill. Import taxes, duties, and customs all add to the TCO. The supply chain professional must include all value added taxes (VAT) that are included by foreign companies. Bear in mind, VAT’s can be charged when moving product from one providence to the next providence within the very same country. In many cases, these VAT’s can be refunded; however, a company must know when and how to do this and they must be diligent in performing this exercise each and every time. Packaging should be considered especially when making shipments via ocean transportation. Is the product purchased susceptible to salt and moisture contamination? If so, then special packaging will be necessary (additional cost). If a company typically operates utilizing “surface” mode of transportation and suddenly finds itself requiring excessive air freight to meet production schedules or to avoid product sensitivity to salt and/or moisture, potential unit price savings become quickly eroded.

Quality Assurance: What is your cost of quality? This element assists in quantifying this cost. By transferring product outside your production facilities or moving product to a new supplier, additional qualification, validation and audit costs will be incurred. Additionally, when products are received from new sources typically some sort of incoming inspection is necessary at least until a defined confidence level is achieved with this new supplier. Unlike the above Logistics category, if the new supplier has a demonstrated quality process exceeding a C_{pK} of 2.0 or better then the model actually reduces cost by a defined embedded factor.

Risk: The risk element is probably the most overlooked and arguably the most subjective when assigning a cost for each individual subcategory. However, by not properly addressing these threats, the exposure a company could face is not only higher unit costs than anticipated; but also, the possibility of not having the product/service necessary to complete the production/assembly of the products/services that are being sold to external customers.

A company known as Global Insight defined the weighted factors for the World Trade Organization (WTO), Currency, and Political Environment used in this model. Other subcategories include lead-times, union vs. non-union environments, delivery performance, formal supply agreements, expediting, and obsolescence. If lead-times are increased, then cost escalation occurs. More inventory is most likely carried. Delivery performance decreases. Expediting costs increase through more airfreight requirements and more phone calls to suppliers. Additional time (“cost”) is required by the supply chain professional as well as various other departments such as production, logistics, quality, and general management, when “baby-sitting” expedited deliveries. The model; however, does reward formal agreements with reduction to cost, but only when the agreement is under the jurisdiction of U.S. commercial law.

Maintenance and Repairs: This element primarily is for capturing cost when capital equipment is necessary for the outsourcing of this product or service. If capital equipment is not necessary then the Maintenance and Repair element will not be a factor when using the TCO model. If capital assets are required, how are the costs of acquisition, depreciation, and maintenance embedded in the unit purchase price?

Administrative and Financing: As a result of outsourcing an internally produced product or transferring a product already purchased to a new domestic or international source, new costs will be encountered. Will the company have to carry extra inventory because of outsourcing? If inventory value goes up the model inserts a factor for carrying costs. If the company does indeed outsource the product/service will the internal burden be relieved? If the internal burden is not eliminated, the model will phase in an additional cost.

Payment terms (and the influence of currency fluctuations) offered by an external source can have either a positive or negative impact to a company's cash flow. If payment terms are favorable when compared to standard terms, the model will reduce the cost of outsourcing; and conversely, if the payment terms are less favorable than current standard terms, additional costs are incurred.

Better business decisions occur by using the outputs from the Total Cost of Ownership model and understanding the cost drivers for each of the above elements.

Total Cost and Lean Principles. Defining lean as "eliminating waste" and "adding value," outsourcing to external sources and potentially international suppliers may be counterintuitive to the seven areas of waste as defined by Lean Principles. The seven areas of waste are shown here with examples of waste in the supply chain.

Overproduction – Suppliers typically produce in larger batches to compensate for inefficiencies in their processes.

Motion – Because the product/service is coming from an external source, additional steps for receiving may be necessary. Is additional incoming inspection a requisite for this outsourced product/service? Supplier qualification and travel may be required to perform the necessary audits.

Inventory – With stacked lead-times, suppliers produce in larger batches and larger deliveries are made less frequently (to maximize ocean container shipments). These all contribute to greater inventories. This excess inventory translates to higher costs derived from increased warehouse space requirements, potential obsolescence, damage, reduction in cash flow and overall carrying costs.

Waiting – Utilizing surface freight from overseas typically requires 30 days on the ocean. This does not include the potential two weeks to move material within the borders of some countries. Stacked lead-times for international shipments have the prospective of being twice as long (more likely three to four times greater) as domestic suppliers.

Transportation – To keep cost low, it is a good intention to keep the freight on the surface. However, due to changes in customer expectations the need to move material via airfreight

emerges. The cost of utilizing airfreight drives a significant negative financial impact when having product shipped hundreds and thousands of miles to its destination point.

Defects – External sources may not fully understand internal requirements. Because of this, higher levels of quality defects may incur additional costs of correction.

Human Potential – Not utilizing the full human potential inside a company translates to higher cost due to inefficient productivity. Productivity may not be as great as it possibly could be. A company should maximize its internal processes and efficiencies. In doing so the company may determine it is not necessary to move the product/service externally in order to compete.

Conclusion. This tool assists in the understanding of the Total Cost of Ownership by calculating the cost of making a purchase both in the United States and in countries such as China, India, and Mexico. The Supply professional can use this tool to plan their sourcing strategy and support the argument for maintaining sourcing internally or outsourcing a product or service to a domestic or international supplier – thus mitigating the risk that translates to increased Total Cost of Ownership.

REFERENCES

- Dobler, Donald W. and David N. Burt. *Purchasing and Supply Management, Text and Cases*, McGraw-Hill Companies, Inc., New York, NY, 1996.
- Global Insite. <http://www.globalinsight.com/>, Service provider for risk assessment based on Political Environment, WTO and currency.
- Womack, James P. and Daniel T. Jones. *Lean Thinking*, Simon and Schuster, New York, NY, 1996.