Beyond the Acquisition Price – Total Cost of Ownership for Supporting Purchase Decisions

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Total cost of Ownership (TCO) is a management accounting technique relevant for supply chain management. TCO concerns the quantification of all costs which coincide with buying, processing, and selling or disposing of purchased goods or services. TCO can be used to support multi-attribute purchase decisions. This paper provides a conceptual discussion of TCO and provides guidelines for companies on a step-by-step implementation of TCO. Furthermore, results from a number of empirical studies on TCO implementation are reported.

Field of Research: Management Accounting, Supply Chain Management

1. Introduction

Economic information on costs and revenues plays an important role for purchasing decisions. In this paper we discuss "total cost or ownership" (TCO) analysis. The aim of TCO analysis is precisely attributing all costs which coincide with buying, processing, and selling or disposing of purchased goods or services. This helps comparing, for example, alternative suppliers, brands, or technical specifications (Carr and Ittner, 1992; Ellram and Siferd, 1998; Morssinkhof, 2007). Examples of relevant costs are:

- the acquisition price and other payments directly linked to it and invoiced by the supplier (such as sales tax, purchased options, and an initial spare parts inventory);
- the costs of installation and usage (e.g., energy costs and maintenance);
- costs of purchasing activities (such as stipulating specifications, writing contracts, identifying and assessing suppliers, placing orders, processing and paying invoices);
- inventory holding costs (financing, insurance, handling, storage, revaluation if purchase prices become lower, discarding or sales price reduction when products go past their sell date or are unfashionable);
- costs which are caused by quality problems (scrapping or repairing products, downtime of machines, customers' complaints, and warranty);

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- costs which do have with the logistics (transportation, delivery timeand reliability, emergency supplies, and flexibility for making agreements such as for delivery windows, order quantities, or packaging).

As these examples demonstrate, TCO is comparable with customer profitability analysis (CPA). The objective of CPA is also to allocate costs more accurately to cost objects, in that case to cost objects such as customers, distribution channels, sales regions, projects, products, etc. that have to do with the *marketing and sales* side of the firm (Foster and Gupta, 1994; Van Triest, 2005). TCO, on the other hand, focuses on the *purchasing* side of the firm. While TCO may be a boundary-spanning concept and stimulate cooperation with suppliers and customers (Wouters et al., 2005), the analysis focuses one firm in the supply chain. Wouters (2006), for example, discusses some of the issues involved when the unit of economic analysis is several companies in the supply chain.

Some sectors use TCO concepts regularly, such as the ICT sector (hardware and software), transportation (trucks, planes), and semiconductors. But the implementation of TCO is limited in many companies (Hurkens et al., 2006). The purpose of this paper is to provide a conceptual discussion of TCO, in Section 2, and to provide guidelines for companies on the implementation of TCO. We emphasize that a company can introduce TCO step-by-step. In Section 3, we summarize findings from several studies conducted by the author.

2. Conceptualization of Total Cost of Ownership (TCO)

Monetary quantification of points of difference

Sometimes purchase decisions are all about "technical" aspects such as quality or functionality, for example when a company develops technologically very challenging products and needs to find suppliers who can produce particular components at all. The purchase price and other costs are not unimportant, but these are not decisive for making a choice.

In other situations, the tradeoff between costs, quality and functionality is important without, however, an explicit economic calculation of TCO being made. Technical data concerning quality and functionality are as such compared to financial differences, mainly the purchase price. That comparison can be made informally, for example because decision makers assess whether the differences in quality or functionality are worth the additional price. Sometimes there are corporate guidelines or simply traditions with respect to the use certain brands or suppliers. The comparison can also be made using formal methods for multi-criteria analysis. For example, every alternative is granted "points" by attribute and it is determined which alternative scores the highest. In all these situations, no monetary quantification of "technical" differences around quality and functionality is performed.

It is however more objective to translate as many aspects as possible to money. This makes it possible to “compare apples to oranges”, and to find out which alternative is economically most attractive for the company. It is important to extend TCO gradually and to build on experience with the financial translation of the most significant "technical" attributes (Wouters et al., 2005).

Table 1 is a simplified example to illustrate the principles here discussed. A number of characteristics of two alternatives are provided, and some of these attributes have been already expressed “naturally” in Euros (purchase price, residual value, maintenance costs). For other attributes, the financial impact can be calculated: The production line of Brand A needs 1 operator per shift less, and this gives a saving of € 100,000 per year. Brand A requires less time for cleaning, and this makes a difference of about €14,000 per year. Brand B consumes less electricity, and that provides a saving of about € 1300 per year. Also there are characteristics that have not been converted into money in this example: The reputation of the supplier of Brand A is better. This can a role play in the decision-making, but it is questionable whether this can be expressed meaningfully in Euros at all. Moreover, the uptime and the production speed are different. This means that both machines can produce the required production volume of 27.5 million units per year; however only Brand A has some overcapacity (almost 29 million units per year can be produced, versus 27.65 million). Can this difference be made financial? It may not matter for the final decision in this example, but possible overtime and/or outsourcing results in a cost advantage for Brand A.

	Alternative options			
	Brand A		**Brand B**	
Available information:	Data	Financial impact*	Data	Financial impact*
Initial investment production line	€ 3,000,000	already financial	€ 3,300,000	already financial
Residual value after 5 years	€ 1,000,000	already financial	€ 1,250,000	already financial
# Operators	7	€ 700,000	6	€ 600,000
# Shifts	2		2	
Maintenance costs per year	€ 120,000	already financial	€ 150,000	already financial
Cleaning (laborhours per day)	10	€ 71,100	12	€ 85,320
Electricity (kwh per day)	220	€ 9,108	190	€ 7,866
Uptime	98%	not translated	96%	not translated
Production speed (units/hour)	8500	not translated	8000	not translated
Supplier reputation	Excellent	not translated	Good	not translated
		* per year		

Further data (these apply to both alternatives):	
Production 8 hours per shift, 5 days per week, 45 weeks per year	
Labor cost per operator per year	€ 50,000
Cost of capital	20%
Cleaning cost per hour	€ 31.60
Price per kwh	€ 0.184
Production volume per year	27,500,000

Table 1: Example with 2 alternatives

Recommendations for implementation:

- Gather information concerning different kinds of attributes: financial (unit of measurement is €, $, £, ¥, R$); quantitative, non-financial (example: delivery time); qualitative (example: supplier reputation).
- Select those attributes which are likely to have the largest *differential* costs. Require such a monetary quantification of points of difference for these most significant attributes.
- Establish corporate guidelines for the valuation of other-than-price differences (such as inventory).
- Assign someone in the team the explicit “cost analyst” role.
- Involve suppliers. Require them to provide information on key “technical” data of the financial consequences of these.

Measurement of outcomes

TCO can be related to *expected*, future costs, if it is conducted to support the selection of a purchasing alternative; or it can be related to the so far effectively *realized* costs. For the TCO technique this makes no fundamental difference, but it does concern the supporting data. A calculation of the *expected* TCO is made if still must be chosen between several alternatives. As far as a company as actual experience with particular alternatives, internally gathered data can be used concerning costs, reliability, quality, etc. Typically, suppliers are asked to supply additional data. A calculation of the *realized* TCO is restricted to that alternative that has been chosen in the past. The comparison with other purchase possibilities is not relevant anymore, but the comparison with original objectives is. Measurement can be financial or more "technical" of nature. When for the decision-making a number of important nonfinancial parameters have been identified as the most significant ones, these parameters are measured in practice. In the example in table 1 it makes sense to measure the real maintenance costs, cleaning time, uptime, and production speed.

Recommendations for implementation:

- Make not only an analysis on expected costs, but also verify the actual outcomes.
- Of the selected alternative, analyze which parameters have the largest influence on the *total* costs.
- Measure these parameters in practice.

Economic summary measure

Economic analyses can be made on the basis of cash flows, or on the basis of revenues and costs (accounting terms). Cash flows are the correct basis for evaluating decisions, and we see this most clearly for investment decisions. These are decisions which go paired with large initial cash outflows for assets which are used during several years (and for this reason are investments on the balance). An investment analysis maps this initial cash outflows and the annual

cash flows, and summarizes all of these using a discount factor to correct for the different moments on which these cash flows occur. This is called "net present value ", and this is a form of TCO. The NPV is the basis to compare alternative investments. Comparison of TCO can also be made on the basis of the costs per year, per kilometer, per hour, per unit, etc., using depreciation costs instead of cash flows. In the example in Table 2, the costs per year of Brand A and B are compared. The costs of Brand B seem lower. A correct comparison, on the basis of the cash flows, however, shows that Brand B is slightly more favorable. The difference arises because the cost comparison does not take into account the time value of money (for example the fact that the residual value will only be received after 5 years).

		Alternative options	
		Brand A	**Brand B**
Cost per year:			
Depreciation		€ 400,000	€ 410,000
Other costs		€ 900,208	€ 843,186
Total costs per year		€ 1,300,208	€ 1,253,186
Total costs per unit		€ 0.0473	€ 0.0456
Net present value:	Discount factor*		
Initial cash outflow	1.000	€ 3,000,000-	€ 3,300,000-
Present value cash flow year 1	0.833	€ 750,173-	€ 702,655-
Present value cash flow year 2	0.694	€ 625,144-	€ 585,546-
Present value cash flow year 3	0.579	€ 520,954-	€ 487,955-
Present value cash flow year 4	0.482	€ 434,128-	€ 406,629-
Present value cash flow year 5	0.402	€ 361,773-	€ 338,858-
Residual value	0.402	€ 401,878	€ 502,347
		€ 5,290,295-	€ 5,319,295-

* $1/1.20^0 = 1$; $1/1.20 = 0.833$; $1/1.20^2 = 0.694$; etc

Table 2: Comparsion of cost calculation and net present value

Recommendations for implementation:

- For purchase decisions about investments, use an analysis on the basis of cash flows. A conversion into accounting costs is possible, but doing it correctly is much extra work.
- Decisions that do not involve investments can be based, however, on the basis of a simplified calculation of the costs per unit. The theoretical objections are less of an issue in this case.

Contractual implications

After TCO analysis has been carried out, a "normal" contract can be concluded, but it is also possible that the supplier gives hard guarantees for the effectively realized TCO, or for some specifications which are decisive for the TCO. For example: suppose that in a TCO calculation the costs of spare parts usage of a machine play an important role, then is possible in the contract for this machine to include a condition for the maximum costs of these parts. Or suppose that in a

TCO calculation the speed of a machine has been identified as a key factor, then a clause can be incorporated in a contact stipulating that the supplier must pay a "fine" if the specified speed is not achieved.

Still a step further is that a supplier is no longer paid for the products or services as such, but on the basis of an “all-in” price per performance unit. An example is when the supplier of car components builds these in the car on the assembly line and is paid per unit produced. Other examples are a supplier of a production line being paid per produced unit of product, or a supplier of work wear being paid per employee per working day, a supplier of a copier/printer per sheet of paper.

Recommendations for implementation:

- Strive for concrete guarantees concerning costs or parameters which have significant influence on the TCO. Guarantees give faith, because these are indications of the degree to which the supplier dares to share in the risks and gains.
- Take care that your own cost accounting is sufficiently refined that you understand the costs by kilometer, hour, copy, etc., before the payment basis is adapted. Doing the analyses first is important for knowing whether the “all in” price is realistic.
- On purchase markets where this type contracts is already common practice, suppliers can be compared directly.

Revenue consequences

The analysis of TCO of purchase decisions has been so far been restricted to the costs (or cash outflows) for the buying party. Thereby we have assumed implicitly, that what is bought, has no impact on the functionality or quality of the end product (or service) of the buying company. But what if purchase decisions do have such an impact on the quality or functionality of end products, and thereby on the sales volume and/or sales price? For example, a producer of wine compares several types of bottles and labels. Beside differences in the purchase prices of the bottles and labels, there are quality differences which are of influence on the efficiency of the filling lines, and also some bottles and labels more attractively than others. Suppose that the sales price of wine depends of the attractiveness of the bottle and the label. In that case analysis of purchase-related costs (or cash outflows) is not enough; the purchase-related revenues (or cash inflows) also have be also considered

Recommendations for implementation:

- Involve marketing and sale in purchase decisions.
- If the impact of purchase decisions on sale of end products is relevant, focus TCO analysis on those issues.

TCO-based marketing of your firm’s offerings

Above we made a connection between TCO and marketing and sales, but TCO also has to do with marketing and sales in a different way: Companies can use TCO for the marketing and sales of their products or services (Anderson and Narus 2004; Anderson, Kumar and Narus 2007). TCO as a sales argument demand a "cross-border" analysis, because the selling company needs data concerning the use and the costs of the own products or services at the customer. In fact, a company will take the perspective of its customer and conducts TCO analysis of its own products or services. That requires, of course, that you understand which alternative is considered by your customer, so that you can focus the analysis at the comparison and your product or service with that alternative. It is especially intended to demonstrate that a possible higher acquisition price is compensated by lower other costs (or cash outflows) or by extra revenues (or cash inflows).

Also now, TCO analysis rapidly becomes too complex and too demanding regarding the required data. For this reason it has been already emphasized above to focus the analysis of TCO at the most important differences between alternatives. In fact, it does not need to be an analysis of the "total cost or ownership", but rather of the "differential value or ownership".

Recommendations for implementation:

- Focus the analysis on a comparison with the alternative that the potential customer considers.
- Focus the analysis at those aspects which are different between your own product/service and that of the competitor.
- Work with customers to learn the TCO of your own products and services.
- Take care that you can show a value proposition to your customers: what is the financial advantage which they can gain by buying your product or service, instead of certain alternative products or services?
- Combine the knowledge and experience of purchase and sale, for example: let purchasers from your firm evaluate your own value propositions.

3. Research findings

In this section we will summarize a number of research findings from studies in which the author was involved. One research issue is: what weight do decision makers attach to attributes that cannot accurately be included in the financial TCO summary measure? Sometimes alternative purchase options differ on a number of important criteria, of which however the financial consequences cannot be valued accurately. When decision makers have TCO information in which these criteria are therefore not or inaccurately incorporated, which weights attach decision makers to these criteria? We conducted a study using several experimental tasks, in which a total number of 2097 people participated. They consisted of students and of people with professional experience. We found that

people with more professional experience tended to give these criteria a small weight, probably because they focused mainly on the aggregate TCO numbers calculated for these alternatives. Decision makers with less experience, however, tended to give to these criteria a larger weight, perhaps because these criteria became more salient (Morssinkhof 2007, Morssinkhof et al. 2007).

Another study looked at the organizational setting of TCO implementation. Which factors influence successful application, which is especially relevant considering the many practical problems which must be overcome? Data were gathered through a survey that pertained to buying items for maintenance, repair and operating supplies (MRO items). Overall, 160 purchasing managers and 150 maintenance representatives completed usable questionnaires, leading to satisfactory net response rates of 35.9% (purchasing) and 31.2% (maintenance). Using structural equations modeling, a number of hypotheses were tested. Results showed that the purchasing orientation contributes to successful application: a professional, modern purchase organization in the company. It also helps if the company has already experience with systematically analyzing the implications of purchase alternatives; then the step to a financial analysis is small. In contrast to findings in American literature, it appears that it is not needed to firstly adapt the system of performance review and reward. That follows after gaining sufficient knowledge and experience with TCO (Wouters et al., 2005). Results also showed a number of significantly different perspectives between purchasing managers versus maintenance managers.

In a follow-up study, we focused on TCO during new product development. A survey was used to gather data at the level of new product development projects. Respondents were pairs of project leaders and cost analysts who had worked on the same project. The data were analyzed using structural equations modeling. It was found that monetary quantification was a key element of successful TCO application. Furthermore, senior management could hold teams accountable and require them to justify their decisions: please explain how the team supports their decisions on what to buy using analyses of cost and performance that go beyond the acquisition price (Wouters et al., 2007).

In a still ongoing study we focus on TCO for marketing and sales, but then already during product development. This is a follow-up study to Anderson et al. (2006). During product development still many freedom degrees of freedom exist to adapt the design, with the aim of reducing TCO. And moreover, a company can this way better decide on what to spend the limited budgets for product development. On the other hand: during product development far less is known concerning application possibilities at customers. Which contribution provides the product or process in raising the efficiency and/or the effectiveness of the company process of the customer? What are next-best alternatives in the eyes of the customer? And when a technological break-through is involved: which changes can appear in the complete sector with regard to users, competitors, business models, and new applications? With so much uncertainty it is still much

more complex to market new offerings on the basis of TCO. This study is framed as a management practice study, and it is based on case studies of innovative firms. Results are not yet available.

4. Conclusion

TCO is potentially an important instrument for purchase management. There are several forms to introduce TCO. In this paper we have discussed alternatives and a number of recommendations for the gradual implementation of TCO are given. Some recommendations are:

- Start small: analyze the financial impact of the most significant differences between purchase alternatives.
- Verify assumptions: obtain feedback from the field and measure actual outcomes of key attributes.
- Share risks: incorporate guarantees concerning the most important parameters and costs in the purchase contract.
- Know your TCO: provide the customer with well-founded information on the TCO of your own product or service in consuming markets business.

However, monetary quantification is difficult, and this leads to a number of interesting questions for research. At the organizational level: what factors contribute to successful TCO application? At the individual level: how are attributes weighted which are not on only partially included in TCO? We reported a number of empirical findings on these issues.

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