



Effects of providing total cost of ownership information on attribute weights in purchasing decisions

Sebastiaan Morssinkhof^a, Marc Wouters^{a,*}, Luk Warlop^{b,c}

^a University of Twente, School of Management and Governance, PO Box 217, 7500 AE Enschede, The Netherlands

^b Katholieke Universiteit Leuven, Faculty of Business and Economics, Naamsestraat 69, B-3000 Leuven, Belgium

^c Norwegian School of Management (BI), Nydalsveien 37, N-0484 Oslo, Norway

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ABSTRACT

Total Cost of Ownership (TCO) involves the monetary quantification of nonfinancial attributes and the subsequent aggregation of these attributes into a financial summary measure. We consider monetary quantifications that are not perfect, because some attributes are missing from the TCO information. We investigate how the provision of TCO information affects attribute weights, and how this effect is moderated by the *Comprehensiveness* of quantification and the decision-maker's experience. We conducted experiments with 817 participants, both students and managers. We found that student participants were more inclined to give a higher weight to the attribute missing from the TCO information, while the practitioner participants tended to give less weight to the missing attribute. Within the group of practitioners, the pattern was strongest for the most experienced practitioners. The results suggest that experienced decision makers might be less mindful of the imperfections of monetary quantification.

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1. Introduction

Purchasing decisions involve choices between alternative supplier offerings, characterized by different attributes, such as acquisition price, product quality, and the supplier's delivery reliability. Often these different attributes are non-comparable, because their measurement units are not commensurable, making multi-attribute decision-making exceedingly difficult for managers (Bettman et al., 1998). Total Cost of Ownership (TCO) information can potentially support purchasing decision makers through the monetary quantification and aggregation of attributes. Specifically, attributes that are not initially expressed as a financial unit of measure are "translated" into financial numbers. These financial numbers are subsequently aggregated into a summary measure (Anderson and Dekker, 2009b; Carr and Ittner, 1992; Degraeve et al., 2000, 2004; Ellram and Siferd, 1998; Wouters et al., 2009).

Not every consideration that matters in a business setting, however, may be quantifiable in monetary terms (Galbraith, 1973; Chapman, 1997). We investigate what happens when some nonfinancial attributes are monetarily quantified and included in the TCO information, while other nonfinancial attributes are *not*

monetarily quantified and therefore not included in the TCO information. Do the attributes that are *not* included in the aggregate financial TCO information receive more or less weight as a result of providing the purchasing decision maker with imperfect TCO information? Financial information is particularly influential in decision-making (Reck, 2001; Kadous et al., 2005; Nolle et al., 2008). As a result, monetary quantification may inadvertently draw attention away from attributes that are not expressed financially.

We will investigate the *Comprehensiveness* of quantification and experience as moderating variables. *Comprehensiveness* refers to the number of attributes that are included in the overall TCO summary measure. *Experience* refers to general professional experience that leads to an understanding of purchasing, operations, and the usage of cost information in organizations. *Experience* does not refer to specific, technical accounting knowledge.

Experiments were conducted with students and managers, 817 participants in total. The purchasing decision involved making a choice between two brands (A and B) for a similar new machine in a production department; the selection of Brand B was the dependent variable (*Choice B*). The experiment used a $2 \times 2 \times 2 \times 2$ between-participants design: the three manipulated, independent variables are availability of Total Cost Information (*TCO info*), the *Comprehensiveness* of the information provided (*Comprehensiveness*), and the uptime of Brand B (*Uptime B*); *Experience* was a measured, fourth independent variable. Thus, there were 16 cells with different experimental conditions. This

* Corresponding author. Tel.: +31 53 4894498; fax: +31 53 4892159.

E-mail addresses: s.morssinkhof@utwente.nl (S. Morssinkhof), m.j.f.wouters@utwente.nl (M. Wouters), luk.warlop@econ.kuleuven.be (L. Warlop).

study did not consider incentives, and no information about reward structures related to this purchasing task was provided.

We found that decision-makers adjusted their strategy depending on the situation. When few attributes were included in the TCO measure (*Comprehensiveness* is low), we found that *students* put more weight on the attribute that was not included in the TCO measure, consistent with Hypothesis 1. For practitioners this condition did not yield a statistically significant result. When more attributes were included in the overall TCO measure (*Comprehensiveness* is high), we found that *practitioners* put less weight on the missing attribute, consistent with Hypothesis 2. However, students still put more weight on the missing attribute, contrary to Hypothesis 2. We also conducted further analyses by splitting the group of practitioners into more and less experienced subgroups. We found that the results for the less experienced subgroup resembled the students' results more than the results of the more experienced subgroup. Taken together, these findings suggest that *Experience* is an important factor, and providing TCO information to experienced decision makers may lead them to put less emphasis on attributes that are not incorporated in the cost information.

The remainder of this paper is structured as follows. In the next section, the background of this paper is introduced in more detail and our hypotheses are developed. Subsequently, the research method is described, and results are presented. Discussion and conclusions are in the final section.

2. Hypotheses development

2.1. Monetary quantification and aggregation through TCO

Sourcing decisions are based on diverse information. We define *financial* information as information about attributes with a monetary unit of measurement—Euros, Dollars, or any other currency—acquisition price, or labor cost, for example. *Quantitative, nonfinancial* information is information about attributes that take a non-monetary, quantitative unit of measurement; examples include attributes regarding delivery time, production speed, process yield, or size tolerances. Finally, we define *qualitative* information as information about attributes that is expressed in words, such as a description of a supplier's innovative capabilities, or testimonials from a supplier's other customers (Narasimhan, Talluri and Mahapatra, 2006). A key issue is how to combine diverse information in order to understand what the "overall" best alternative is (Ramanathan, 2007). Methods for multi-criteria analysis (de Boer et al., 2001; Dulmin and Mininno, 2003) support such decision-making, for example through rating, while monetary quantification and aggregation are key elements of TCO information (Bhutta and Huq, 2002).

Monetary quantification means that attributes that are not initially expressed in a monetary unit of measurement are "translated" into financial numbers. For example, if energy use is initially expressed as "kilowatt per hour", then this may be translated into the "energy cost per hour". Monetary quantification usually requires additional data or assumptions, and therefore may not be feasible for some attributes (Bhutta and Huq, 2002). The attributes with a monetary unit of measurement can be aggregated in order to compare alternative sourcing options.

Aggregation can be done in different ways. Considering that sourcing decisions may involve a time horizon that spans over several years, one needs to apply discounted cash (Verbeeten, 2006). The cash flows that are expected to occur at different points in time are discounted to their present value. These values are, in turn, added up to calculate the net present value. The sourcing alternative with the highest net present value is

preferred. Internal rate of return and payback time are other measures for comparing alternatives based on discounted cash flows. Another way to aggregate financial attributes is based on the diverse costs throughout the value chain and the product life cycle (Anderson and Dekker, 2009a). The different costs for a particular sourcing alternative are combined to calculate a cost per product (or another relevant unit, such as per kilometer, per hour, per kilogram). Cost is not a cash flow concept but an accrual accounting concept. The difference can, for example, be illustrated by considering investments in fixed assets, such as production equipment. When applying discounted cash flows, the initial payments for the asset are included in the calculation along with the payments the firm receives when the asset is sold again in a later period. However, when looking at costs, a depreciation cost is included in the calculation. The difference between the initial cash outflow and the cash inflow when the asset is sold—the total loss in value of the asset—is spread over the periods in which the asset was used. This is called a depreciation cost and it is not a cash flow.

The present study assumes aggregation based on costs. We study a cost accounting method that more or less captures the "ideal" Total Cost of Ownership (TCO). These costs may, for example, include transaction costs related to purchasing activities, like ordering, freight, and quality control; inventory-holding costs, such as capital, storage, handling, insurance, and obsolescence costs; costs related to poor quality, such as rejection, rework, downtime, and warranty costs; or costs related to delivery failure to customers (Carr and Ittner, 1992; Ellram and Siferd, 1998). The scope of TCO should involve not only routine activities of the purchasing department, but TCO should extend to more strategic activities of purchasing, such as supplier selection, developing relationships with important suppliers, and participating in new product development (Armstrong, 2002). TCO information can also be used for services (Degraeve et al., 2004; Hurkens et al., 2006) with recent approaches examining the inclusion of supply risks (Micheli et al., 2009). TCO information may also play a role in the negotiations between buyers and suppliers (Piontkowski and Hoffjan, 2009; Van den Abbeele et al., 2009).

However, like all costing information, TCO is almost always an imperfect representation of the underlying decision problem. For most managerial decisions, it is impossible to translate every relevant aspect of the decision into a financial metric, and accounting information cannot generally quantify all relevant aspects through formalized, financial numbers (Galbraith, 1973; Chapman, 1997). For example, it may be that choosing a better quality supplier leads to lower costs for scrap, labor, inspection, and warranty, but the cost accounting system may not be able to trace all these cost savings to that particular offering. It could be, for example, that only material, scrap, and labor cost savings are traced to the product level, while reduced costs for inspection and warranty are shown at a higher level, as part of the overhead costs for the total plant, for instance.

Cost information from outside the firm's accounting system may also be needed for estimating the TCO for sourcing alternatives, such as from other, non-accounting related, information systems within the firm or from suppliers. A firm's cost accounting system only captures the costs of the offering it has actually purchased, and even then, only a selection of costs is recorded. For example, opportunity costs, associated with stock out and delayed production, are often far greater than the purchase price of materials (Anderson and Dekker, 2009b).

This paper focuses on the *Comprehensiveness* of TCO information. It investigates the effect of providing TCO information on decision weights in a multi-attribute purchasing decision when some attributes are monetarily quantified and aggregated into a

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