This paper explores whether total cost of ownership (TCO) analysis can be used by industrial suppliers to demonstrate the superiority of their offering to customers. Existing scholarly literature addressing this question is shown to be very limited and even contradictory. An embedded case study comprising a focal machinery supplier and six customer companies is conducted to understand the issue at depth. Altogether twenty-two interviews are conducted with sellers and buyers to identify antecedents and obstacles to sell-side TCO analysis. Based on six obstacles identified and in light of the existing literature, it is proposed that TCO analysis is inapplicable as an industrial marketing tool. In its place, a less comprehensive differential cost approach is suggested. Semantically distinguishing between differential cost and TCO reconciles the contradictory literature, and also allows a conceptual framework to be constructed where the notions of differential cost and TCO are considered subcases of differential value and total value of ownership respectively.

Keywords: Total cost of ownership (TCO), value quantification, industrial marketing, industrial machinery

Type of paper: Competitive
INTRODUCTION

Over the last decades, capital equipment manufacturers with expanding installed bases have increasingly turned to service provision as their core products have faced commoditization and demand stagnation (Gebauer et al. 2012; Jacob & Ulaga 2008). In the machine manufacturing industry, the basic after-sales offering is geared towards putting the original equipment through its useful life by providing MRO supplies (maintenance, repair and operations items such as spare parts and consumables), along with intangible services such as maintenance and tech support. In this installed base market, original equipment manufacturers (OEMs) compete not only with each other, but also with third party service providers and specialized spare part manufacturers. To succeed in differentiating themselves from the competition, it is critical for machinery OEMs and parts suppliers to understand how their customers value and select aftermarket product-service bundles for maintaining their capital equipment. Like other business marketers, machinery suppliers need to be able to calculate, demonstrate and document the value of their offering, including services (Kindström 2010; Lilien et al. 2010; Anderson et al. 2007).

From a procurement perspective, industrial buyers of MRO supplies and services should, ideally, aim to buy in such a way that total cost of ownership (TCO) is minimized, rather than just buying on a low price basis (Wouters et al. 2005; Ellram 1995). Accordingly, aftermarket suppliers need to be able to demonstrate the extent to which their products and services lower the lifecycle costs of the customer’s capital equipment. Consequently, some authors have suggested that TCO analysis can be used by suppliers as a powerful selling tool (Piscopo et al. 2008; Brown 1979), whereas others have argued that using the methodology in industrial marketing is unpractical (Anderson et al. 2007, p.8). While buy-side TCO analysis is a well-known concept (e.g. Ferrin & Plank 2002; Ellram 1995), almost nothing has been published on sell-side use of the methodology. Moreover, the little that has been published appears to be conflicting with regard to the applicability of TCO analysis as an industrial marketing tool.

The purpose of this study is to explore whether and how total cost of ownership analysis can be used by MRO and other industrial suppliers to demonstrate the superiority of their offering to the customer. This is done through an embedded case study in paper machine MRO market—comprising a focal supplier (Metso Corporation, a multinational machinery manufacturer) and six of its large customers (pulp and paper companies).

This paper is structured as follows. Next, the research questions and methods are described, followed by a review of the scholarly literature on sell-side TCO analysis. Then, the case study is presented in two parts: the focal supplier case and the customer case; both also being available in more detail in Appendix B and C. The first part of the case describes why Metso engaged in a sell-side TCO development initiative. The second part of the case explores the business context of Metso’s TCO initiative from the perspective of six of Metso’s major customers in the pulp and paper industry, with the aim of identifying obstacles to implementing TCO sell-side. In the discussion section, the antecedents (“whys”) and obstacles (“why nots”) are used to propose that TCO analysis in inapplicable as an industrial marketing tool. The implications of this proposition are then discussed with regard to prior theory and management practice, laying the foundation for a new framework for distinguishing TCO analysis from other closely related methods. Finally, the paper concludes with a concise summary of the methods, findings and implications.
METHODOLOGY

The inquiry into sell-side total cost of ownership analysis is guided by the following three research questions:

(1) What empirical evidence is there in the academic literature that proves sell-side TCO analysis has been successfully applied in an industrial context?
(2) Why would a MRO supplier attempt to use TCO analysis as an industrial marketing tool?
(3) What are the main obstacles to sell-side use of TCO analysis?

To answer the first research question, a systematic overview was conducted of the academic literature dealing with TCO analysis specifically in industrial marketing and sales. The second and third questions were answered using the case study method, which was appropriate because little was known a priori about sell-side TCO analysis, and a proper examination required delving into real field conditions.

By investigating these questions, the following three contributions are made to the existing academic literature. First, no systematic overview has been conducted of the literature dealing with TCO analysis in industrial marketing and sales. Piscopo et al. (2008) did cite much of the available research in support of their study, but this paper provides an assessment of the totality of evidence. Second, while TCO initiatives and adoption in procurement has been studied (e.g. Wouters et al. 2005), there are no published descriptions of the driving forces behind TCO initiatives in industrial marketing and sales. This gap is filled herein by describing three antecedent circumstances that led the machinery manufacturer to engage in such an initiative. Third and finally, while the obstacles to buy-side TCO analysis are well known (e.g. Ellram 1994), almost nothing has been published regarding the obstacles characteristic of sell-side TCO analysis. This study establishes six such obstacles in their business context by turning to the machinery manufacturer’s customers for their views on the topic.

Literature search strategy

For the literature review, the bulk of articles were found primarily through comprehensive keyword search in the search engines Google Scholar and Web of Science, which generated articles from databases such as ABI/Inform, Business Source Complete, Emerald, and ScienceDirect. The main topical keywords used were “total cost” and “total cost of ownership”, along with similar concepts such as “life cycle cost” and “life cycle costing”. These were in combined in various ways with and without contextual keywords such as “industrial”, “industrial marketing”, “business marketing”, “manufacturing” and “MRO”. Together, this search strategy yielded scientific articles and other scholarly publications that were relevant both in terms of topic and in terms of business context. Hundreds of abstracts, articles and a few books were scrutinized for in-text discussion on TCO and equivalent concepts in conjunction
with industrial marketing and sales. Then, from key contributions identified, forward and backward citation analysis was performed to find additional relevant material that had slipped through the keyword search.

Altogether, only five articles and two books were found that discussed the use of total cost of ownership analysis in the sales context (summarized in Table 6 in Appendix A). This is not surprising, as TCO analysis has traditionally been the domain of procurement and supply chain management. The lack of research on the topic made it unnecessary to use bibliometric analyses to establish and assess the current state of the literature. Rather, a simple tabulation and labeling sufficed.

**Case study method**

As sales and procurement are counterpart activities, merely studying a supplier is not enough to generate a complete picture of an inter-firm activity. Sell-side use of total cost of ownership analysis entails a supplier understanding customers’ costs, rather than merely a customer understanding their own costs. Consequently, the case in this study encompassed both a focal supplier and multiple of that supplier’s customers. Because the customers were examined in isolation as well (not strictly in relation to the focal supplier), this study is best described as an *embedded case study*, as it contains more than one sub-unit of analysis (Yin 2003, pp.42–43).

The focal supplier selected for this study was Metso Corporation—one of the two main manufacturers of paper production lines in the world. At the time of empirical data collection, one of Metso’s business units was conceptualizing a sell-side TCO initiative related to their paper machine MRO offering for pulp and paper companies. MRO sales arguably constitutes a *typical* or even *critical case* (Yin 2003, p.40) for TCO analysis as an industrial marketing tool, because MRO items are particularly suited to pure cost-based comparison, as they do not normally affect how the final market offering (e.g. wholesale paper) is perceived downstream from the manufacturer (Wouters et al. 2005). Metso’s TCO initiative, was about developing new TCO-based sales models for paper machine consumables (also called *consumable parts* or *wear parts*), which are core process machinery spare parts that gradually and visibly wear out due to friction, necessitating frequent replacement. To keep the case study manageable, the product scope was ex ante restricted to three types of high-cost consumables:

1. Roll covers—rubber or synthetic coatings that are affixed to paper machine rolls
2. Paper machine clothing—woven textile belts that drain water and transport the sheet of paper through the paper machine (also called “fabrics”; with subtypes “felts” and “wire”)
3. Doctor blades—long and thin blades that continuously clean the paper machine rolls of water and contaminants

This setting provided a unique view into *why* a supplier of MRO goods and services would attempt to use total cost of ownership as an industrial marketing tool. This was a key question with regard to the use of sell-side TCO analysis, because the methodology must serve the underlying needs behind the initiative; in other words, the ends must justify the means. Qualitative research interviews were used to secure a view into the business problems driving the initiative. The free-form discourse was generated through a total of 15 hours of unstructured interviews with twelve sales and general managers responsible for the paper machine consumables business at Metso. Old MRO contracts, sales pitch presentations and other documents were collected to triangulate the findings from the interviews. Additionally, three paper mill visits were conducted to better understand field conditions.
The findings from the focal supplier case were used to inform the formulation of an open-ended interview protocol (see Appendix D) for subsequent semi-structured customer interviews. The customer case study explored the business context of Metso’s TCO initiative from the company’s customers’ perspective, with the purpose of identifying plausible obstacles, “why not(s)”, to the implementation of sell-side TCO analysis, without having to longitudinally follow up a multi-year implementation attempt. Six customer companies were selected using purposeful sampling (Patton 1990, pp.182–183), to arrive at a reasonably variant but accessible set in terms of size, location and procurement orientation. The customer informants listed in Table 1 include MRO decision-makers from central procurement, mill operating staff, and mill management—all purposefully selected to provide mutually complementary views.

Ten semi-structured interviews were conducted, some of which had more than one interviewee present. In the interviews, documents and spreadsheets were exchanged to clarify and corroborate data, and some interviews were followed-up for further elaboration. As new information was obtained, the interviews gradually became a way of testing the internal validity of the conclusions of this study. The total of 22½ hours of customer interviews were transcribed word-for-word into a 150 000 word compendium, which allowed for accurate recollection and facilitated writing the customer case discourse in a rigorous fashion. The qualitative data was analyzed by grouping themes, aggregating similar arguments and juxtaposing differing points of views. The analysis was then organized using theory-building structure (Yin 2003, p.154) where each of the case sections culminates in the inference of an obstacle to sell-side TCO-analysis. Finally, the antecedents (“whys”) and obstacles (“why nots”) were used to make inferences with regard to the applicability of sell-side TCO analysis as an industrial marketing tool.

<table>
<thead>
<tr>
<th>Company</th>
<th>Position</th>
<th>Location</th>
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<td>Category manager</td>
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<td>M-real</td>
<td>Supply manager</td>
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<td>Production manager</td>
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<td>Papierfabrik Palm</td>
<td>Managing director</td>
<td>Mill / Corporate</td>
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<td>Stora Enso</td>
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<td>Corporate</td>
<td>S1</td>
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LITERATURE REVIEW

All goods and services bought as an input to a firm causes the firm to incur costs, of which the most conspicuous is the price. All purchases induce other types of costs as well, because it is necessary for the buying firm to spend additional resources on acquiring, using, and ending the use of the product or service. It is thus possible to sum up every cost associated with particular purchase from a particular supplier, and thereby arrive at a figure for the true cost induced by that purchase (Degraeve & Roodhooft 1999b; Ellram 1995). This figure—the total cost of ownership—is a quantification of all costs associated with the purchasing process throughout the entire value chain of the firm (Degraeve et al. 2000), or at least an approximation by including only the most significant cost elements (Ellram 1995). Throughout this paper, we use Anderson & Narus’ (2003, p.98) pragmatic definition of total cost of ownership as “the sum of the purchase price plus all [attributable] expenses incurred during the productive lifetime of a product or service minus its salvage or resale price”¹. This definition is operationalized in Equation 1 and is illustrated graphically in Figure 2.

$$\text{TCO} = \text{purchase price} + \sum \text{attributable expenses} - \text{salvage price} \quad (\text{Eq. 1})$$

Figure 2: Conceptual illustration of total cost of ownership

The method of calculating this monetary figure is called TCO analysis², and it is an application of activity-based costing (ABC) to procurement (Wouters et al. 2005; Degraeve & Roodhooft 1999). Traditionally, activity-based costing was used to solve the issue with simplistic overhead allocations causing inaccurate profitability estimates for the company’s own products. The essence of ABC was to first allocate factory overhead, corporate overhead and other organizational resources to activities performed by the organization and then make allocations to products on

¹ The attributable expenses and the salvage value may be incurred years after purchase, and should thus be discounted to their present value (Forbis & Mehta 1981). Also, the “price” here means the pocket price after discounts (Marn & Rosiello 1992).
² To avoid ambiguity, this paper uses the term “TCO analysis” for the methodology, whilst plain “TCO” or “total cost” refers to the numerical cost estimate that is the output of the TCO analysis; a distinction not made by most academic authors on the subject.
the basis of the products’ demand for activities (ibid.). In TCO analysis on the other hand, costs are allocated to purchases on the basis of the activities that the purchases impact. Such activities may occur on hierarchically on the supplier level, order level, batch level and unit level (Degraeve & Roodhooft 1999). Every purchase is followed up by supplier and item, thereby making it possible to compare the total costs brought about by different items from different suppliers (Wouters et al. 2005). To put it briefly, while traditional ABC allocates overhead to individual products, TCO analysis allocates overhead to individual factors of production.

ADVANTAGES AND LIMITATIONS OF TCO ANALYSIS

The main goal with TCO analysis is to make better purchasing decisions by considering cost issues beyond price (Ellram & Siferd 1993). Apart from improved supplier selection and volume-allocation, TCO analysis can also be used for supplier performance evaluation, driving major process improvements and to provide data for negotiations (Ellram 1995). In comparison with widespread supplier selection models such as ratings models and linear weighting models, the theoretical advantage of TCO analysis is that it makes different criteria comparable in monetary terms without resorting to subjective valuations (Degraeve et al. 2000). The comprehensiveness of a TCO analysis may however range from simply trying to capture the most significant cost elements using the Pareto principle (Ellram 1994), to sophisticated models based on mathematical programming (Degraeve & Roodhooft 1999; Degraeve et al. 2000; 2005).

While TCO analysis is a theoretically sound approach to procurement, empirical studies have shown limited use of method in practice. Ellram & Siferd (1993) queried 103 purchasing managers and reported that only 18 % of used a formal TCO model, 24 % didn’t use TCO at all, while the remaining 58 % used some kind of informal model. For MRO items, Ferrin & Plank (2002) reported a meager 10 % TCO analysis usage rate in 274 manufacturing companies. And even in companies where TCO has been used, managers have indicated that the systems are vague, inaccurate or otherwise untrustworthy (Milligan 1999). The primary reason for the low rates of TCO usage appears to be the lack of readily available data (Hurkens et al. 2006), which stems from a lack of good computer systems, along with the labor-intensity of collecting and inputting cross-departmental data (Milligan 1999). Note that TCO is not appropriate for all buys, because the modeling itself can take hours or weeks to conduct (Ellram & Siferd 1998).

The main theoretical limitation of using TCO analysis to understand the economic impact of supplier’s offerings is that the analysis focuses on costs only (although possibly including straightforward opportunity costs), while ignoring harder-to-estimate revenue effects downstream from the purchasing firm (Wouters et al. 2005). This means that in cases where the revenue-side effects are significant, TCO analysis by itself is not sufficient for evaluating the economic impact of a sourcing decision. Wouters et al. (2005) have called for academics to expand total cost of ownership into a “total value of ownership” concept—which would recognize that higher priced offerings may generate revenue improvements rather than cost savings—but no such all-encompassing analytical concepts have emerged to date. The issue with downstream revenue effects is however not usually a problem in MRO items, because they generally do not

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3 Ellram (1995) refers to TCO models based on performance category scoring as “value-based TCO models” as opposed to “dollar-based TCO models” which are based on ABC costing. In this paper, “TCO” strictly means the latter type, because the former “value-based TCO models” are similar to regular ratings models in that weightings are subjectively determined; the only difference being a rather arbitrary conversion of a score into a monetary figure.
affect the performance of the market offering, as perceived by the customer (Wouters et al. 2005).

**Can TCO analysis be used as a sales tool?**

While TCO analysis is an established procurement methodology, it does *not* automatically follow that the method can be successfully applied on the opposite end of the negotiating table. Sell-side use of TCO does not appear to be widespread, as is indicated by Ellram & Siferd’s (1998) study, which identified 21 uses for TCO analysis in 11 industrial companies, *none* of which was using TCO analysis as a sales tool.

Table 6 below contains an overview of all academic literature found discussing sell-side TCO analysis. Only seven scholarly publications were found mentioning the use of TCO analysis in the context of industrial marketing and sales. Brown (1979) argued that life cycle costing is useful in the marketing of higher-priced industrial products that provide long run cost savings. Similarly, Stremersch (2001) briefly suggested that maintenance firms need to develop TCO calculators to sell full-service maintenance contracts. Other authors were more inquisitive in their approach. Plank & Ferrin (2002) concluded their article by asking how sales people should be trained to change the buyer’s valuation system from price-orientation to TCO. Zachariassen & Arlbjørn (2011) saw an avenue for future research in determining the effects of negotiating situations where sellers have more TCO data than the buyers. The only peer-reviewed article providing any kind of empirical evidence on the matter is Piscopo et al. (2008), who argue that TCO can be a powerful tool for business marketers based on a sales case from Rockwell Automation.

The use of TCO in sales is not without its detractors. Anderson et al. (2007, p. 8) contend that TCO analysis is “unworkable in practice”, because customers have limited patience in cooperating with suppliers and only a limited willingness to share data. They further argue that efforts to calculate TCO regardless of these limitations leads to “filling out forms, guessing, and recycling opinions—in place of actually gathering data” (ibid.). In an earlier book however, Anderson & Narus (2003, p. 339-341) did recognize Rockwell Automation’s “TCO-toolbox” as best-practice consultative selling. The reason for this discrepancy appears to be that Rockwell’s approach does not normally drill down into *all* the costs and steps in the customer’s entire production process (Anderson et al. 2007, p. 123), thus implying that Rockwell’s normal sales efforts using the TCO-toolbox software solution is not a fully-fledged TCO analysis. A comprehensive analysis is only done if the customer requires or asks for it, and in that case, Rockwell uses specialized internal consultants rather than salespeople to conduct the analysis (ibid.).

To conclude the literature review, little research on TCO in sales has been conducted, and scholarly opinions are either inquisitive or offer contradictory opinion on whether it works or not. There is almost no empirical evidence in the academic literature that proves sell-side TCO analysis has been successfully applied in an industrial context. The single successful case described in the literature is one where the buyer collaborated with the seller to conduct a partial TCO analysis only. In business, the absence of evidence is, more often than not, *evidence of absence*. Nevertheless, based on Rockwell’s success case, it may be possible to use TCO analysis on a case-by-case basis to compare the supplier’s suggested solution with the existing one. This will require a very cooperative customer and may require the use of internal or external consultants to conduct the analysis.
FOCAL SUPPLIER CASE STUDY

Metso Corporation is a multi-billion euro global supplier of industrial machinery for heavy industries such as the pulp and paper industry. A strategic focus for the company is the service business for its installed base, which comprises spare parts and consumables, maintenance, repairs, rebuilds, and various process analyses and optimizations.

In the paper machine consumables business, Metso’s position is one of higher price and higher value—which stems from delivering bleeding-edge technology and providing free supplementary services. As an original equipment manufacturer (OEM) of paper machine consumables, the most difficult competitors for Metso are the multitude of small specialized consumables manufacturers rather than other OEMs. The reason is that the niche competitors can sustain significantly lower prices at the same level of technology, partially due them being able to free-ride on the OEMs’ heavy R&D through spin-outs and employee attrition. The imitation process has also made it more difficult to effectively differentiate original consumables from non-OEM consumables, consequently leading to greater price sensitivity in customers—to the detriment of Metso’s market share.

To convince customers that Metso’s offering is worth the higher price, sales people tended to rely on slideshows with qualitative bulleted lists of benefits, e.g. using statements such as “we provide process support to reduce paper sheet breaks”. These types of contestable claims were however considered rudimentary by managers, who contended that they should somehow be able to quantify the benefits of the offering in monetary terms, but had failed to do so because of a lack of good metrics and calculation methodology.

In 2010, one of Metso’s largest customers issued a pamphlet termed “Total cost of ownership (TCO) business opportunities”. This was a simple bulleted list of methods MRO suppliers could use to reduce the total costs for the customer, such as energy savings and product life extension. This explicit interest in total cost considerations by a key customer was quickly recognized by Metso’s sales managers as a list of ways to differentiate their consumables offering from the lower-priced niche competitors, and as a consequence, the “TCO” acronym subsequently caught on at Metso. Inspiration was drawn from Sweden’s bearings manufacturer SKF, which used total cost of ownership as a metric in its “Documented Solutions Program”—a systematic effort to document the value added delivered to the company’s customers (Snelgrove 2008). SKF’s freely available sales materials were circulated internally at Metso, with the aim of adopting concepts already known to work.

The next year, in 2011, Metso launched a pilot sell-side TCO development initiative pertaining to its paper machine consumables business, with the goal of boosting sales. The initiative included rudimentary development of spreadsheet costing models, and also packaging product-service bundles using the “TCO” label. This flurry of activity led to semantic confusion among sales and general managers regarding the meaning of the term “TCO” and how it related to existing notions of “package deals”, “solutions”, “supply contracts” and “value-based pricing”. Nevertheless, the logic behind its use was clear to the few managers familiar with the formal definitions for total cost of ownership. They reasoned that Metso, as a paper machine OEM, understands the total costs associated with machine consumables better than the paper companies buying them. At Metso, managers believed that the customers’ lesser understanding of the total costs, particularly among non-technical purchasing professionals, biased the customers towards

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See Appendix B for a more extensive version of the focal supplier case study.
buying low priced consumables and not sufficiently accounting for indirect cost elements. None of Metso’s customers were known to utilize formal TCO analysis for selecting MRO suppliers; not even the large customer that originally suggested opportunities to reduce total costs. Yet the implicit view among Metso’s employees was that if the customers were to do such calculations in a rigorous fashion, they would find that Metso’s higher priced consumables offering would in fact have the lowest TCO among all consumable suppliers. Therefore, the argument goes, Metso could argue that it is the best supplier by performing the TCO calculations proactively for the customer and thereby getting customers to focus on total costs in the long run instead of just looking at the sticker price.

ANTECEDENTS TO THE SELL-SIDE TCO INITIATIVE

From the company’s managers’ perspective, the logic behind the initiative was the following: First, Metso’s OEM-level prices were consistently undercut by niche competitors specializing in manufacturing certain consumables, and customers were happy to select the lower priced substitutes. Second, Metso’s managers believed (or wanted to believe) that paper companies were making suboptimal procurement decisions because of their focus on acquisition price, and that Metso’s offerings were more economical when taking into account cost savings from better technology and bundled services. Third and finally, a major customer had designated total cost of ownership considerations as a business opportunity.

Although this is only a single case, we can infer, through the force of example (Flyvbjerg 2006), that three antecedents may lead a MRO supplier to attempt to use TCO analysis as an industrial marketing tool:

**Antecedent 1:** The supplier is higher priced, but the incremental value over low-price substitutes is contestable.

**Antecedent 2:** The supplier believes that all things considered, its offering is the most economical for the customer.

**Antecedent 3:** There is some explicit customer interest in total cost of ownership.

CUSTOMER CASE STUDY

Pulp and paper companies manufacture paper by grinding and dissolving wood and recycled paper into pulp, which is pressed and dried in a paper machine to become paper. The paper produced is sold in large batches to publishers, converters and printers, who subsequently process the bulk paper into end products.

A considerable cost element for paper mills are MRO supplies and services. In a newsprint mill, for instance, MRO may account for roughly 10% of variable costs (Diesen 2007, p.150). The procurement of high-cost MRO items like paper machine consumables is organized in two different processes. On the corporate level, there is a central buying organization responsible for negotiating and administering multi-year framework agreements. The framework agreements typically either recommend or dictate certain volume distributions among preferred suppliers, based on aggregated opinions from the company’s paper mills. On the mill level, local purchas-

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5 See Appendix C for a more extensive version of the customer case study.
ing agents carry out day-to-day purchase order requests based on local needs, mainly by referring to existing framework agreements, but sometimes through mill-specific contracts of their own making when technical considerations necessitated it.

SUPPLIER SELECTION METRICS

All paper companies surveyed wanted to reduce the price of their paper machine consumables by driving down suppliers’ margins. The central procurement organizations did this by employing a competitive negotiation strategy, which entailed creating an atmosphere of aggressive price competition through competitive bidding and threats of substituting existing suppliers. Through the competitive bidding processes, the paper companies usually selected three preferred suppliers in each category and distributed volumes based on suppliers’ bids. All companies used one of the following two basic methods of supplier selection: (a) pick the supplier with the lowest bid price among a set of qualified suppliers, where the pre-qualification is based on mills’ subjective experience and technical assessments; or (b) pick the supplier with the highest overall score in a linear weighted point plan with both quantitative and qualitative criteria. Even though corporate buyers were aware of hidden costs, they were rarely monetarily quantified and almost never combined to produce a total cost figure.

Consider a MRO supplier whose value proposition is based on the premise that their offering has the lowest TCO. To substantiate the claim, such a supplier would have to present believable total cost calculations for potential customers during framework agreement negotiations. Customers however, do not base their final decision on TCO, but rather on price or a weighted score of subjective factors. This would put the supplier in a position where they would have to make the customers change their supplier selection method. Considering the multiple difficult steps necessary to implement systematic use of TCO in procurement (Wouters et al. 2005), it is implausible that a MRO supplier could impose TCO as the customer’s metric of choice. Thus we note a generic obstacle to sell-side use of TCO analysis:

**Obstacle 1**: Customers do not use TCO analysis for supplier selection.

CREDIBILITY OF SUPPLIERS’ TCO CALCULATIONS

While paper companies’ central procurement was concerned with the formal negotiation of corporate-wide framework agreements for paper machine consumables, every paper mill still bore ultimate responsibility and had some leeway for what suppliers to use, what consumables to run, and what investments to make. From a mill’s perspective, the only way to determine the truthfulness of suppliers’ sales arguments was to conduct a trial (feasibility study) on the machine where the consumables were supposed to be installed. The reason was that paper machines are both unique (what worked on one machine is no guarantee that it will work on another similar machine) and complex (overall effects of new parts cannot be predicted from first principles)

« Every salesman says that their product saves energy and lasts longer based on tests in other machines, but nothing is a fact until it a trial has been conducted on our machine. It’s up to us to assess whether a trial is needed and whether we believe that the supplier has the potential to become a large supplier for us in the future. A supplier can come and show us a TCO breakdown, but they can’t really show anything other than their own price breakdown without running a trial at our mill. And even then, we’d be very wary of revealing any details about our costs. You don’t want to go out on the street shouting about how much money we’d lose in a three hour outage, because that information could be used to deduct our financial outlook. »

~ Supply manager, M-real
Even if discounts were given, mills did not easily participate in trials. Not only would trials cause additional work for both management and factory employees, but also involve the risk of the supplier transferring intimate knowledge from the mill to competing mills. Furthermore, a failed trial would worsen the mills’ key performance indicators, such as machine efficiency or production schedule compliance. Consequently, a supplier cannot show up with theoretical TCO calculations in a sales pitch and expect customers to buy anything based merely on those calculations. We thus conclude the following:

**Obstacle 2:** Sell-side TCO calculations become credible only through risky, resource-intensive and highly collaborative field testing at the customer’s site.

**TCO as an Extension of Supplier Price Breakdown Analysis**

None of the paper companies surveyed reported using formal total cost of ownership analysis for MRO supplier selection or otherwise, with the exception of a few sporadic analyses made by purchasing managers at UPM. Nevertheless, most purchasing managers demonstrated some degree of familiarity with the method when shown a conceptual TCO breakdown. In particular, a few noted that TCO analysis was similar to breaking down the supplier’s price into cost component (for an illustration, see the TCO breakdown in Figure 5 in Appendix C on page 40).

At Zeta, they reported conducting price breakdowns (cost breakdowns) independently based on suppliers’ financial statements and market data, to be used as tool for resolutely negotiating smaller margins with suppliers. At UPM, on the other hand, the sourcing staff asked supplier’s sales people to voluntarily provide the cost structure for their products, by emphasizing open books collaboration to reduce the total costs in the supply chain.

« When talking about TCO-models, we need to really open all the cost drivers. From the end of the pipeline at the mill where the product is used, to the beginning of the pipeline where the product is manufactured. [...] We need this type of thinking, but nobody [expletive] opens up the costs of their products [properly]. [...] I believe that the supplier who figures this out and goes down this road will enjoy a big competitive advantage. In the end it doesn’t matter whether the margin is 100 percent or 300 percent as long as the price is competitive. Thank God and good for them if they have a huge margin, that’s always better. [...] But nobody wants to open up their prices, because they are afraid that the discussion will inevitably turn to the magnitude of the margin. [...] That’s not what I want to do at all. I want to discuss about how to drive costs down [together] so that the margin remains the same.[...] The tragicomic thing is, that [although we’ve managed to do a few fine analyses], we’ve never once, during my time at least, put a TCO model on the table together with the mill and the supplier and said: “Alright, let’s start thinking about how we can reduce this [TCO] for real”. »

~ Category manager, UPM

Suppliers who want to use TCO analysis to prove they are the most economical will inevitably open up the discussion on their cost structure. The reason is that from the customer’s point of view, the price of the offering is a big chunk of the TCO of the offering. TCO could therefore be reduced by helping the supplier reduce their costs, which begs the question on what the supplier’s costs and margins really are. Suppliers won’t be keen to reveal this information, fearing that it would worsen their negotiating position and leak to competitors. Even if suppliers were to voluntary provide product cost breakdowns, it would be difficult for customers to assess whether or not any of the cost elements contained hidden margins, thus leading to a squabble on what the true margin is. It may even be the case that suppliers don’t know what their true margin is, e.g. because of intricate internal transfer pricing systems, or favoring traditional absorption costing over more accurate activity-based costing. We therefore conclude:
**Obstacle 3:** Sell-side TCO analysis may necessitate the seller to reciprocally reveal the true cost structure of their offering.

**MEASURING KEY TCO DRIVERS FOR PAPER MACHINE CONSUMABLES**

For paper machine consumables, key TCO drivers included useful life, energy use and inventory costs. However, their influence on total costs is not straightforward to ascertain. Energy use needs to be accurately measured locally in the machine, but paper machines lack the necessary instruments. Useful life is negatively correlated with annual replacement costs, but the exact relationship depends on the re-optimization of the machine’s shutdown cycle. Inventory costs may be arduously estimated through conventional means, but it is unclear what the cost savings are due to consignment inventory services.

Faced with these complexities, buyers considered hidden costs in terms of differences between offerings, rather than attempting to estimate each cost element in absolute terms as one would do in TCO analysis. For instance, while the absolute energy use of a doctor blade and roll cover dyad could theoretically be estimated, buyers were only interested in determining energy consumption differences between offerings. Similarly, buyers cared little for total inventory costs, but still expressed interest in inventory cost savings. Also, the cost-effect of useful life only makes sense to consider in relative terms.

The reason why buyers only cared for cost differences was that they had no alternative but to buy machine consumables, since the papermaking process cannot run without them. This means that when making a sourcing decision, buyers were interested in quantifying cost differences, if any, rather than figuring out the magnitude of all the hidden costs associated with an offering. Total cost of ownership would only matter in the hypothetical case where (a) it was on par with or exceeded the opportunity cost of not buying, or (b) a substitute pay-for-performance service existed.

Generally speaking, buyers have little to gain in collaborating with a supplier in conducting a fully-fledged TCO analysis, since the TCO analysis will entail quantifying complex cost elements that may be equal amongst competing offers. We conclude:

**Obstacle 4:** Sell-side TCO analysis requires allocating all the customer’s costs attributable to the offering, regardless of cost driver complexity and regardless of whether the magnitude of a cost element is expected to vary by supplier.

**REVENUE EFFECTS AND TCO**

A key consideration with regard to the overall performance of a paper machine consumable is its effect on the rate of paper production. However, TCO by definition only takes into account expenses incurred over the productive lifetime of the asset or product. If a machine consumable makes it possible to increase the rate of production, then the benefit will be a revenue increase rather than a cost reduction. Similarly, if a consumable makes it possible to run new paper grades with better margins, then that too would count as revenue improvement. Therefore, whenever a type of machine consumable changes the output of the production process, then total cost of ownership only tells part of the story on profitability. It is of course possible to make a correction to the TCO figures by deducting revenue increases, but in that case, it would no longer make sense to talk about total cost. Moreover, it is very difficult for machinery suppliers to make accurate revenue side estimations, as they have little or no knowledge about each mill’s market situation and margins by paper grade. As a sell-side industrial marketing tool, TCO analysis will
therefore be of limited use whenever the competing offerings affect the output of the customer’s paper production process.

**Obstacle 5:** Revenue improvements are not within the scope of total cost of ownership analysis.

**ALTERNATIVE USAGE OF THE TERM “TCO”**

Although actual usage of TCO analysis was rare among paper companies, the word ‘TCO’ was nevertheless part of the industry lingo. ‘TCO’ held several mutually incoherent meanings and was equivocally used as by suppliers in sales pitches. Congruently with the definition of TCO used herein, ‘TCO’ could loosely stand for “capital equipment lifecycle costs”, commonly referring to the whole paper machine’s long-run costs of operation. Accordingly, a ‘TCO contract’ referred to a long-term MRO delivery contract or other agreement emphasizing or guaranteeing post-purchase process improvements. On the other hand, TCO’ was in some companies used in a specific sense inconsistently with the academic notion of TCO—i.e. the sum of the purchase price plus expenses attributed through activity-based costing (as defined on page 5). Table 2 summarizes these findings.

As shown in Table 2, two of the companies had specific alternate notions of “TCO”. Boise used the term “TCO reduction” to describe a cost decrease or revenue improvement of the entire production line through capital equipment improvement projects; as calculated using the net present value method (for an illustration, see Figure 6 in Appendix C on page 47). Zeta, on the other hand, used “TCO” formally in lieu of total cost of acquisition (basically price less discounts), adjusted downwards by a mutually agreed figure for savings generated and documented after the purchase (see Figure 7 in Appendix C on page 49 for an illustration).

These alternative notions of “TCO” are inconsistent with the conventional notion of total cost of ownership, which is the purchase price plus expenses attributed through activity-based costing. If a MRO supplier attempts to base its value proposition on lowest total cost using sell-side TCO analysis, it will lead to semantic dispute with customers already having a well-established (albeit erroneous) method of calculating TCO. We conclude:

**Obstacle 6:** Customers may have well-established but unconventional definitions and methodologies for “TCO”, which are inconsistent with proper TCO analysis.

<table>
<thead>
<tr>
<th>Company</th>
<th>Use of TCO analysis</th>
<th>Specific use of the term ‘total cost of ownership’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boise</td>
<td>No</td>
<td>“TCO reduction” ≈ net present value of a capital equipment improvement project</td>
</tr>
<tr>
<td>M-real</td>
<td>No</td>
<td>Not used</td>
</tr>
<tr>
<td>Papierfabrik Palm</td>
<td>No</td>
<td>Not used</td>
</tr>
<tr>
<td>Stora Enso</td>
<td>No</td>
<td>Similarly to academia</td>
</tr>
<tr>
<td>UPM-Kymmene</td>
<td>Sporadically</td>
<td>Similarly to academia</td>
</tr>
<tr>
<td>Zeta</td>
<td>No</td>
<td>“TCO” ≈ total cost of acquisition, including guaranteed post-purchase savings</td>
</tr>
</tbody>
</table>
DISCUSSION

Total cost of ownership analysis is an activity-based costing method conventionally used by procurement professionals to objectively quantify and aggregate hidden costs attributable to a product or service from a particular supplier. This allows comparing different suppliers in terms of total cost rather than basing sourcing decisions on price alone or on subjective weightings of price and non-monetary criteria. Under TCO evaluation, a higher priced offering may turn out to be the most economical in terms of total costs, and should thus be favored over low-price substitutes.

This study viewed total cost of ownership from the opposite end of the negotiating table. Could a higher-priced supplier faced with price-oriented customers use TCO analysis as a sales and marketing tool to demonstrate the superiority of their offering?

Existing academic literature dealing with this question is scant, largely speculative, and even offers contradictory opinion on whether TCO is worthwhile pursuing as a sales tool. A thorough keyword search yielded only five peer-reviewed articles and two scholarly books mentioning TCO analysis in the industrial marketing context; out of which the only extensive examination was provided by Piscopo et al. (2008), who conjecturally argued in favor of sell-side TCO. In spite of the advocacy, all published empirical evidence giving credibility to sell-side TCO analysis revolve around sales cases at Rockwell Automation. Although these may serve as proof of concept, closer scrutiny nevertheless reveals that the calculations only account for subset of all hidden costs. This begs the question as to when a cost model is comprehensive enough to be deemed a total cost model.

In light of the limited research on sell-side TCO, this study set out to explore the topic in greater depth through an embedded case study in the paper machine maintenance, repair and operations (MRO) market.

ANTECEDENTS TO SELL-SIDE TCO INITIATIVES

The focal supplier narrative suggested three antecedents that may drive a MRO supplier to engage in a sell-side TCO initiative. These are listed in Table 3 below.

Table 3: Antecedents to sell-side TCO initiatives as suggested by the focal supplier case.

<table>
<thead>
<tr>
<th>Antecedents</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The supplier is higher priced, but the incremental value over low-price substitutes is contestable.</td>
<td></td>
</tr>
<tr>
<td>2. The supplier believes that all things considered, its offering is the most economical for the customer.</td>
<td></td>
</tr>
<tr>
<td>3. There is some explicit customer interest in total cost of ownership.</td>
<td></td>
</tr>
</tbody>
</table>

Antecedent 1 is a contributory cause to sell-side TCO initiatives for two reasons. First, there must be significant uncertainty with regard to the hidden costs (and possibly benefits) of competing offerings, since otherwise the analysis would be superfluous. Second, the higher the supplier’s price in relation to substitutes from other qualified competitors, the greater is the burden of proof placed on the supplier to show how the price difference will be recuperated by the customer in the long run. Sell-side TCO analysis allows quantifying post-purchase cost savings, hence the incentive for the higher priced supplier to pursue it.
Antecedent 2 then states that the supplier must believe TCO analysis would show its offering as the most economical for the customer, since only in that case would a sell-side TCO initiative be beneficial. Conversely, if the supplier is being outmatched by competitors on a total cost basis, then a TCO analysis would only make the inferiority clear to customers as well.

Antecedent 3 is a powerful trigger for a sell-side TCO initiative, because here an important customer could be explicitly demanding total cost considerations rather than a low price. With a single credible business case at hand, middle managers championing the TCO initiative are thus more easily allocated critical resources by top management to pursue it.

While the above antecedents may appear self-evident in hindsight, Metso’s TCO initiative exemplified a messy reality where few managers understood why and what they were actually developing. After a key customer triggered the initiative, the word ‘TCO’ quickly became a buzzword running rampant in the organization. Not only was it incorrectly applied in cost calculations, but the label ‘TCO’ was also stamped on service-heavy contracts and pricing schemes, thereby leading to considerable semantic confusion.

**OBSTACLES TO SELL-SIDE TCO ANALYSIS**

The customer case study suggested six obstacles to sell-side TCO analysis (Table 4).

Table 4: Six obstacles to sell-side TCO analysis

<table>
<thead>
<tr>
<th>Obstacle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Customers do not use TCO analysis for supplier selection.</td>
</tr>
<tr>
<td>2.</td>
<td>Sell-side TCO calculations become credible only through risky, re-source-intensive and highly collaborative field testing at the customer’s site.</td>
</tr>
<tr>
<td>3.</td>
<td>Sell-side TCO analysis may necessitate the seller to reciprocally reveal the true cost structure of their offering.</td>
</tr>
<tr>
<td>4.</td>
<td>Sell-side TCO analysis requires allocating all the customer’s costs attributable to the offering, regardless of cost driver complexity and regardless of whether the magnitude of a cost element is expected to vary by supplier.</td>
</tr>
<tr>
<td>5.</td>
<td>Revenue improvements are not within the scope of total cost of ownership analysis.</td>
</tr>
<tr>
<td>6.</td>
<td>Customers may have well-established but unconventional definitions and methodologies for “TCO”, which are inconsistent with proper TCO analysis.</td>
</tr>
</tbody>
</table>

Obstacle 1 may appear trivial, but it underlines the fact that sell-side TCO analysis aims to *change* the how customers select suppliers, at least on a case by case basis. This is a fundamental obstacle because customers may have spent years on developing and honing the ways they currently select suppliers, e.g. bidding processes and subjective weighted point systems. Conversely, if a customer did use TCO analysis for supplier selection, then suppliers would be best off by cooperating and providing reliable data.

Obstacle 2 emphasizes that it is impossible for suppliers to conduct believable TCO analyses without access to the customer’s data, particularly on the performance of competitors’ products and services. Although theoretical calculations and referential analyses from other machines may spark interest, collaborative field testing is ultimately needed as proof because MRO items can be very sensitive to machine specific conditions. Such field tests are not only laborious, but also risky due to the increased possibility of machine failure during the trial.
Obstacle 3 is a result of the supply chain perspective on total costs. One of the benefits of a TCO analysis is that it reveals the hidden cost elements with the most improvement potential, thereby enabling the customer and the supplier to collaboratively work out ways of reducing the customer’s total costs. From the customer’s perspective however, the supplier’s price is a cost element amenable to the same improvement principles. The customer might therefore, in the spirit of cost reduction collaboration, demand that the supplier reveals the cost elements that make up the price of the product or service. This is an obstacle to sell-side TCO analysis because not only does the supplier have to reveal sensitive sales margins, but the supplier would also have to know the cost structure of their own product-service bundles. This may be surprisingly difficult or even impossible without a corporate-wide full costing system in place.

Obstacle 4 is a practical consequence of how total TCO is defined. As established on page 5, total cost of ownership, as the name suggests, measures the true cost of a purchase by including all expenses attributable to the product or service throughout its useful life. Consequently, significant cost elements cannot be omitted from a TCO analysis while still proclaiming it to be total cost of ownership, as that would misrepresent both the meaning and the accuracy of the analysis. This is a major obstacle to sell-side TCO analysis, because many key cost drivers are difficult or even impossible to quantify and allocate without the customer already having implemented activity-based costing systems for the very purpose. Moreover, some cost drivers may be inconsequential with regard to the sourcing decision if their magnitude is not expected to vary by supplier, but TCO analysis necessitates their quantification regardless.

Obstacle 5 is another consequence of the definition of total cost of ownership. TCO analysis allocates cost overhead to procured products and services, but ignores the effect that these products and services have on revenues. In other words, while TCO is an accurate measure of the firm’s inputs, it ignores outputs and therefore says nothing about the input-output difference, i.e. the profitability of the firm’s inputs. This limitation is sensible from an accounting perspective because an input to the firm is generally combined with a multitude of other vastly dissimilar inputs to produce outputs, so revenues cannot be objectively allocated to individual inputs to arrive at a “total profit of ownership”. For sourcing decisions, this is not a problem as long as the revenue effects among competing offerings are identical, in which case the best supplier is the one delivering the lowest TCO. However, as it turns out, even functionally similar MRO items may affect the buying company’s revenues by altering end product quality or quantity. This limits the potential for sell-side TCO analysis to demonstrate the overall impact of an offering because it excludes quantifying how the customer’s revenues will be affected.

Obstacle 6 is a type of semantic discord where a customer already has an established way of calculating “TCO”, but the method is inconsistent with the academic notion of TCO analysis. ‘Inconsistent’ here means that the method is not just a sub-activity of TCO, such as total cost of acquisition or landed cost, but rather a calculation based on principles other than activity-based costing. For example, this case study demonstrated an instance where the word ‘TCO’ strictly meant pocket price minus post-purchase documented savings. In such circumstances, suppliers using TCO analysis as an industrial marketing tool may have a particularly difficult time coming to terms with the customer.

SYNTHESIS OF THE ANTECEDENTS AND OBSTACLES

Together, the antecedents and obstacles discussed above reveal a mismatch between (a) what a supplier is trying to achieve with sell-side TCO analysis, and (b) what feasibly can be achieved
using the methodology. The supplier’s objective is to motivate their higher price and win deals by demonstrating that their offering is more economical for the customer than competitors’ lower priced substitutes. The allure of TCO analysis is that it adds all hidden costs on top of the purchase price, thereby revealing which of the alternative offerings is the cheapest in terms of total costs for the customer. This is advantageous for the higher priced supplier as long as the higher price translates to correspondingly lower hidden costs for the customer, and thereby lower total costs.

While some of the obstacles to using TCO analysis for this purpose can arguably be overcome with intense effort, some of the shortcomings are so fundamental that they essentially confute TCO analysis as a sell-side tool. TCO analysis necessitates extensive customer-supplier cooperation to model and measure all cost drivers attributable to the product or service, both for the supplier’s offering and for other competing alternatives. This leads to two insurmountable issues. First, it does not make sense to mine the data if the cost of doing so exceeds the expected benefits for both parties—a highly probable situation when dealing with complex cost drivers. Second, TCO analysis includes all or at least the most significant cost drivers (by magnitude), even if they would have negligible bearing on the supplier selection decision. For instance, if all product alternatives in any given decision require about as much inventory, then inventory costs will not affect the decision and need not be modeled, even when inventory costs are a large part of total costs. In other words, customers are interested in cost differences between alternatives, not the absolute total costs per se. The semantically liberal reader may argue that this elimination is allowable in TCO analysis, but, if that were the case, ‘total cost of ownership’ would become a misnomer as it would no longer measure total costs, but would be a sum of e.g. (a) easily measurable cost elements, or (b) the most variant cost elements.

Also, the customers’ objective is to maximize profits, so they are not just interested in reducing costs, but also in increasing revenue, or more specifically, generating more contribution margin to cover for fixed costs. Revenue enhancements are not within the scope of TCO analysis, although this methodological limitation can be overcome by considering the contribution margin increase as a negative cost. The problem is that this might make TCO negative if the revenue enhancement is large enough, which again makes ‘total cost of ownership’ a misnomer.

Based on the prior theoretical arguments and the case study as a whole, the following proposition is inferred:

**Proposition:** Total cost of ownership analysis is inapplicable as an industrial marketing tool.

Assuming this proposition is true, why then is TCO analysis inappropriate in sales but a real possibility in procurement? There seems to be at least three reasons for this. First, unlike a one-off sell-side TCO analysis, buy-side TCO costing systems can be set up permanently and applied to many different product categories, thereby making a much larger initial investment worthwhile. Second, the buyer has direct access to its own cost data and information from all potential suppliers, while a single supplier would have to depend on the buyer share such data. Third, TCO becomes the metric of choice when performance specifications are frozen (i.e. no differing revenue effects), but only buyers are able to make such demands.

**Implications for Industrial Marketing Theory**

The findings in this case study corroborate the assertion made by Anderson et al. (2007, p. 8) that sell-side TCO analysis is “unworkable in practice”. Importantly, this also means that the findings and the main proposition are at odds with Piscopo et al. (2008), who extensively argued that
“TCO analysis can be a powerful selling tool”. This apparent contradiction can be semantically resolved by distinguishing between proper TCO analysis as defined on page 5, which aims to quantify the total cost of each alternative separately, and a superficially similar, but much less comprehensive differential cost approach that only sums cost elements that are expected to vary the most between alternative offerings.

The difference between TCO and differential cost is illustrated in Figure 3. When there are two well-defined alternatives (A & B), it is possible to directly estimate the total cost difference between the alternatives without going through the hassle of computing the total cost of the two alternatives separately first. The reason is that some cost drivers (1, 2, 3) can be eliminated at the outset if there is good reason to expect that they are similar in size for both alternatives, and then quantifying only the remaining variant cost drivers (4, 5).

With these considerations, it appears that the single empirical evidence published in favor of sell-side TCO analysis by Piscopo et al. (2008) could be better described as a differential cost approach, since the case example from Rockwell Automation only contains the top four cost drivers in terms of cost savings. This is also indirectly confirmed by Anderson et al. (2007, p.123), who noted that Rockwell’s “TCO analyses” are most often limited in scope and “really do not drill down into all [emphasis in original] the costs”. Consequently, the proposition that TCO analysis is inapplicable as an industrial marketing tool is not in conflict with existing evidence. Rather, there is unfortunate ambiguity among both procurement and marketing scholars and practitioners as to what counts as “total cost of ownership”, and how it relates to customer value models (compare e.g. Snelgrove 2012; Anderson et al. 2007, p.8 ,123; Wouters et al. 2005; Plank & Ferrin 2002; Anderson & Narus 1998; Ellram 1995; Forbis & Mehta 1981). In particular, there is a need to pragmatically distinguish TCO analysis from the differential cost approach and also establish a clear connection with other subsuming notions such as differential value—the value difference between an offering and its next best alternative (Anderson et al. 2010)—and the proposed total value of ownership, which is TCO extended to include revenue effects (Wouters et al. 2005).
An instructive way of distinguishing between these four concepts (total cost of ownership, differential cost, differential value and total value of ownership) is suggested in Table 5. The idea is to consider circumstances where each of the four metrics represents the relevant objective function in the supplier selection problem. The differential cost approach will only lead to an optimal decision if there is a simple choice between alternatives. ‘Simple choice’ means that it must be possible to conduct an isolated pairwise comparison of two (or more) discrete offerings, eliminate seemingly equal cost drivers, and then make the correct choice on the basis of the differential cost. In contrast, the choice is not simple if there are significant trade-offs and other interdependencies between an offering and other goods and services bought. For example, the inventory costs of two competing products could appear equal at first sight, but may drastically change with time depending on batch sizes, which depend on delivery truck fill-rates, which depend on the mix of different products bought from the same supplier. Other examples include discount and rebate schemes that depend on total volume spanning multiple product groups. Due such interdependencies, the optimal solution to the supplier selection problem might be to buy a particular product mix from several different suppliers using a volume allocation rule that changes over time. This optimal solution cannot be found via the differential cost method (which always suggests a single supplier), but can be generated programmatically using sophisticated TCO analysis, which includes all cost drivers (see e.g. Degraeve et al. 2005; Degraeve & Roodhooft 1999).

<table>
<thead>
<tr>
<th>Is there a simple choice between alternatives?</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the revenue effect differ between alternatives?</td>
<td>No</td>
<td>Total cost of ownership (e.g. Degraeve &amp; Roodhooft 1999)</td>
</tr>
</tbody>
</table>

Furthermore, both the differential cost approach and TCO can be considered subcases of differential value and total value of ownership respectively, which also take into account performance differences that lead to changes in the buying company’s revenues (and thus profits). For example, if a sourced component is more reliable, then the final product containing that component will also be more reliable and may therefore command a higher price. Differential value (Anderson et al. 2010) between two well-defined offerings not only includes lifecycle cost differences (excluding price differences\(^6\)) but also includes the difference in benefits conferred. Differential value therefore conceptually subsumes differential cost, as long as the price difference is taken into account as well. In the same way, Wouters et al. (2005) suggested the total value of ownership concept to subsume TCO by including revenue effects; however this concept has not been

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\(^6\) Differential value is similar to economic value to the customer (Forbis & Mehta 1981), except that the latter includes price differences as a component of value.
Discussion

further developed, possibly due to the inherent difficulty in estimating the \textit{total} benefits of an offering.

\textbf{Managerial implications}

For industrial marketers aiming to demonstrate the superiority of their offering using monetary quantification, this paper suggests \textit{abandoning attempts at sell-side TCO analysis} in favor of the differential cost (or value) approach. TCO analysis is unfeasible as an industrial marketing tool and will also lead to quantification of cost elements that have little or no bearing on the supplier selection decision. However, the activity-based costing principles that form the basis TCO analysis can be used to selectively quantify hidden costs as part of the differential cost approach. Moreover, single TCO analyses can be used to direct process improvements—a domain where suppliers can provide considerable input and even offer TCO analysis support as a paid service.

Managers in general should avoid using ‘TCO’ as a buzzword. Total cost of ownership is a valid theoretical construct, and TCO costing systems can be implemented buy-side with sufficient investment in data collection processes. There is no good reason to use ‘TCO’ or ‘total cost of ownership’ in place of ‘operational costs’, ‘cost savings’, ‘profit’, ‘net cash flow’, ‘pocket price’, ‘total cost of acquisition’, ‘landed cost’ or ‘value’. It is a no-brainer for suppliers to try to win the customer over by demonstrating hard cost savings or incremental profit in comparison with competitors’ solutions. No customers will be convinced by simply slapping the ‘TCO’ label on marketing material, contracts, pricing schemes and value documentation.

\textbf{Limitations and future research}

The key limitation of this paper is that it only \textit{proposes} that TCO analysis is inapplicable as an industrial marketing tool. The antecedents and obstacles identified are not generalizable per se, but rather explain, through the \textit{force of example} (Flyvbjerg 2006), why there is universal absence of evidence in favor of sell-side TCO analysis. Stronger conclusions (evidence of absence) would require a statistically generalizable sample. However, the proposition emerging at the end of the study still fulfills the hallmarks of good theory: it is parsimonious, testable and logically coherent (Eisenhardt 1989). Importantly, the proposition can be falsified by demonstrating that TCO analysis \textit{is} being successfully applied as an industrial marketing tool in some context. Thereafter, theory development can take place by specifying the business contexts where TCO analysis is applicable, and where it is not.

Future research building on this study can therefore take at least two paths. The first option is to aim for refutation by trying to find one or more successful cases of sell-side use of TCO analysis. The second option, which can be combined with the first one, is to aim for verification and generalization by surveying a statistically significant sample of industrial companies. The case company Metso could be longitudinally followed up in such a study, although at the time of finalizing this manuscript, it appears that the sell-side TCO initiative morphed into more of a post-purchase value documentation initiative similar to that used by bearings manufacturer SKF.

Such documentation of cost savings or value delivered represents another possible avenue for future research. Under the guise of “TCO”, this case study inadvertently uncovered a sophisticated value documentation method where the buying company required suppliers to make up-front cost savings guarantees (on a money-back basis), and then systematically monitored whether or not the supplier delivered those savings. This made price commensurable with the savings guarantee, thus making it possible for high price, high value suppliers to more effectively demon-
strate their worth to cost-conscious buyers. Conversely, suppliers could develop a similar system where they would guarantee savings up-front, and follow through using the differential cost (or value) method cooperatively with the customer. A couple of open questions in this area include:

(1) What types of value documentation methods exist and what are the valuation mechanisms?
(2) How can suppliers develop the risk tolerance to provide up-front guarantees and how can customers ensure that the results can be measured to mutual satisfaction?

CONCLUSION

This embedded case study explored whether industrial suppliers can use total cost of ownership (TCO) analysis to demonstrate the superiority of their offering to the customer. While TCO analysis is an established buy-side management accounting methodology for quantifying the total cost of procured products and services, there are only a few scholarly publications that discuss the possibility of using the method sell-side as an industrial marketing tool. Published empirical evidence on the matter is limited to only a few sales case descriptions, and existing viewpoints are contradictory and largely conjectural.

The focal supplier case of machinery manufacturer Metso Corporation indicated that sell-side use of TCO analysis is intriguing because of explicit customer interest in total cost considerations and an underlying belief that such analysis would reveal the supplier’s higher priced offering to be more economical than competitors’ lower priced substitutes. However, interviews with customer companies revealed six generic obstacles to successful implementation. Most importantly, TCO analysis by definition requires computing or at least approximating the total cost incurred as a consequence of the acquisition and subsequent utilization of a product or service, which leads to inordinately resource-intensive collection of customer and competitor specific data whereof only a fraction actually influences the supplier selection decision.

Based on the mismatch between the focal supplier’s motives and the six obstacles identified, and supported by the lack of favorable evidence elsewhere, this study proposes that TCO analysis is inapplicable as an industrial marketing tool. In place of TCO analysis, sellers can use a less comprehensive differential cost approach that only considers the expectedly most variant cost elements. The semantic distinction between these two methods reconciles conflicting recommendations in prior scholarly literature. Differential cost and TCO can further be considered special cases of differential value and total value of ownership respectively.
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## APPENDIX A: TABULATED FINDINGS FROM THE LITERATURE REVIEW

Table 6: Summary of the findings from the literature review on sell-side TCO analysis

<table>
<thead>
<tr>
<th>Author</th>
<th>Quote</th>
<th>Stance on TCO as a sales tool</th>
<th>Empirical evidence provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown (1979, p.109)</td>
<td>Life-cycle costing is a method of calculating the total cost of ownership over the lifespan of the industrial product. It can be especially useful in the marketing of industrial products that sell for high initial prices, but which provide long-run cost savings.</td>
<td>Positive</td>
<td>None</td>
</tr>
<tr>
<td>Stremersch et al. (2001, p.9)</td>
<td>The findings concerning the decision-making process have important implications for marketing full-service offerings as compared with more traditional, single service, offerings. Maintenance companies (and OEMers) will have to broaden their marketing and sales approach [...] Maintenance firms also will have to be prepared for the longer decision-making process and develop specific tools, for instance to calculate “total cost of ownership,” for specific phases throughout the extended buying process.</td>
<td>Positive</td>
<td>None</td>
</tr>
<tr>
<td>Plank &amp; Ferrin (2002, p.464)</td>
<td>[...] what kinds of training best equip a salesperson to move a potential buyer from short-term direct price valuation to TCO valuation? This research equips industrial marketers to ask whether different sales skills are necessary to sell to buyers using price-oriented valuation schemas versus buyers using a TCO, supply chain or noneconomic valuation logic.</td>
<td>Inquisitive</td>
<td>None</td>
</tr>
<tr>
<td>Anderson &amp; Narus (2003, p. 339-341)</td>
<td>[To structure cost implication questioning,] sales representatives often turn to the total cost of ownership (TCO) analyses [...] Through these TCO assessments, reps and purchasing managers jointly identify and quantify major “points of pain” or cost drivers for the prospect company that might not otherwise be apparent.</td>
<td>Positive</td>
<td>Case Rockwell Automation</td>
</tr>
<tr>
<td>Anderson et al. (2007, p. 8)</td>
<td>Approaches to assessing customer value that are cumbersome in practice or that require statistics experts will be met with resistance, especially from the sales force and customers. Total cost of ownership, for example, is hard to argue with as a concept. The problem is that it proves to be unworkable in practice. Customers have limited patience in cooperating with suppliers because customer managers have greater responsibility and increasing demands on their time.</td>
<td>Negative</td>
<td>None</td>
</tr>
<tr>
<td>Piscopo et al. (2008, p.205)</td>
<td>Sellers can use TCO models to measure, document, and communicate the value that their offering represents to a customer in the way of lower costs relative to the next best alternative. TCO analysis can be a powerful selling tool to demonstrate concrete customer value creation for alternatives that deliver comparable benefits.</td>
<td>Positive</td>
<td>Case Rockwell Automation</td>
</tr>
<tr>
<td>Zachariassen &amp; Arlibjørn (2011, p.459)</td>
<td>[...] our empirical data supports the claim that the use of TCO in different dyadic supply chain relations can indeed become inexpedient. Buyers would present cost data that were used for manipulative purposes, and suppliers reactively responded to. As a result, a reverse situation in which suppliers have more information than the buyer and therefore more power in the negotiation setting could lead to a similar escalation of manipulative tendencies [...], however, the empirical data do not support [nor deny] such a logical conclusion. Future research should address this issue.</td>
<td>Inquisitive</td>
<td>None</td>
</tr>
</tbody>
</table>
As established in the literature review, the use of TCO analysis as an industrial marketing tool is a rare phenomenon that lacks a track record of successful implementations. Yet some companies, like Metso Corporation, decide to pursue uncertain sell-side TCO initiatives anyway. It is not known how many of such initiatives actually succeed, but merely their existence points to a need for some suppliers to demonstrate their impact on their customers’ total costs.

The purpose of the focal supplier case was to establish reasons as to why a supplier of MRO goods and services would attempt to use total cost of ownership analysis as an industrial marketing tool. Understanding the drivers of sell-side TCO initiatives is necessary to fully understand the subsequent obstacles to its implementation as well. At the time the focal supplier interviews were conducted, Metso’s TCO initiative was in the conceptualization phase. Managers were searching for information on TCO and brainstorming ideas on its use in the sale of paper machine consumables. No pilot tests had been conducted however, and existing customers were unaware of the initiative.

This appendix is structured as follows. First, Metso Corporation is introduced and the market for paper machine consumables is described. It is then briefly narrated how low-cost niche consumables manufacturers have put pressure on prices, and how Metso has attempted to change its sales strategy and demonstrate the value of its higher-priced offering. Thereafter, Metso’s sell-side total cost of ownership initiative is discussed, along with the antecedent circumstances that drove the initiative.

Throughout the case study description, all interviewees and company documents are cited using shorthand superscript notation to reduce clutter, e.g. (Z1) or (U3; S2). The focal supplier interviews at Metso are designated M1 to M12 in chronological order, while the customer interviews are denoted as listed in Table 1 on page 4. Internal company documents from Metso (see page 23) are cited as D1 to D10, in no particular order.

INTRODUCTION TO METSO CORPORATION

Metso Corporation is a global supplier of industrial machinery and related services to process industries such as mining, construction, power generation, oil and gas, recycling, as well as pulp and paper. At the end of 2010, the company had 28,600 employees, most of which were located in Finland, China, the US, Sweden and Brazil. Metso’s annual net sales were 5.6 billion euro, of which 45% pertained to service business, 35% to projects and 20% to products. Similarly to other Finnish capital equipment manufacturers such as Kone and Wärtsilä, Metso’s corporate strategy revolves around a strong development of the service business, which comprises spare parts and consumables, maintenance, repairs, rebuilds, and various process analyses and optimizations. The company’s goal is to expand the service business so that it will account for over 60% of the corporate net sales at the bottom of a business cycle and at least 40% at the peak. This growth should be readily attainable by increasing their share of the potential service business stemming from their installed base. Metso has estimated that this market is worth 18 billion euros annually, and that they only have 15–20% market share. A significant part of this market consists of maintenance and repair activities performed by the process industry companies themselves rather than Metso’s competitors. (Metso 2010)
Metso’s Paper and Fiber Technology is one of the company’s three business segments. The segment is divided into three business lines: Paper, Fiber, and Services. Contrary to popular perception, the Metso Paper business line does not produce paper, but rather manufactures paper, board and tissue machines out of steel structures and components sourced from subcontractors. The Fiber business line on the other hand mainly focuses on engineering and project delivery management for the pulp industry, while the actual machinery is mostly manufactured by subcontractors. The Service business line serves customers in the pulp and paper industries with spare and consumables, maintenance and other services. The service business generated 677 million euros in revenue in 2010, out of which 70% came from the sale of spare and consumables. (Metso 2010)

COMPETITIVE LANDSCAPE IN THE MARKET FOR PAPER MACHINE CONSUMABLES

In 2011, there were 8538 paper machines in the world, with a total capacity of producing 450 million tons of paper, paperboard and paper tissue annually (D1). When weighted according to production output, the average paper machine had a technical age of 18 years in 2006 and produced 165,000 tons of paper annually (Diesen 2007, p.111). New machines were being built mainly in China, while capital investments in Europe and North America tended to be mostly machine section rebuilds (Metso 2010). A greenfield pulp and paper mill is roughly a 400–500 million euro investment for a pulp and paper company (M3). The paper production line accounts for 100–200 million of the total investment, while the paper machine itself costs about 30–100 million euros (M3).

In the market for new paper machines, there are two main suppliers, both of which are large multinational industrial machinery manufacturers: Metso Group, with a global market share of 31.3%, and Voith Group with a market share of 30.9% (D2). All other suppliers have less than a 5% market share each (D2). In partial production line deliveries such as machine section rebuilds (≈10 million euro investments), Metso competes with globally operating companies such as Andritz and GLV and more regionally focused companies such as Finnish Vaahto, Taiwanese Yue Li, German Bellmer and PMT Italia (M2, M7, M12) (Metso 2010).

A study by Metso indicated that single paper machines have an average service business potential of up to 10 million euros annually, out of which Metso only has a 0–10% share (M2, M12). The paper machine related service business consists of MRO services, process improvements, and the sale of spare parts and consumables. Spare parts and consumables are not strictly “services”, but are nevertheless included in the notion of industrial service, which comprises all after-market support and parts for industrial goods.

The competitive landscape in consumables is different from spare parts. Analogously to car tires, the demand for machine consumables is quite steady and predictable, because they have to be replaced on schedule when the process has been running for a certain time. They thus differ from non-consumable spare parts such as hydraulic pumps and bearings, which may break down unless properly maintained, but whose remaining life is difficult to ascertain (except statistically in aggregate). Spare parts are mainly provided for the machinery supplied (M2) (Metso 2010), because, like other original equipment manufacturers (OEMs), Metso and its subcontractors are the

7 The term “paper machine” will henceforth collectively refer to machines producing paper, paperboard and paper tissue.
8 The technical age of a rebuilt machine is the age of an equivalent machine that has not been rebuilt (Diesen 2007, p.111).
9 The market share figures provided are the share of machine capacity (in tons of paper per annum) for new machines built between 2006 and 2011. (D2)
only ones with the necessary design specifics \((M2)\). With regard to consumables however, Metso sells parts for machinery installed by both Metso and by its competitors. A considerable portion of the consumables market has been captured by a number of both medium-sized and large companies specializing in manufacturing specific types of consumables \((M11)\). An example is Xerium Technologies, which mainly produces two types of paper machine consumables: machine clothing and roll covers \((M2; M7; M12)\). The reason for the success of the specialized companies in the consumables market is arguably threefold. First and foremost, the same non-proprietary technologies can be utilized in manufacturing consumables for large ranges of machine designs \((M2)\). Second, for any given paper machine, the long-term costs associated with consumables far exceed those of spare parts, thereby making consumables a high-volume business worth specializing in \((M8; M11)\). Third, consumables have to be continuously replaced for the paper machine to keep running, thereby leading to a stable and predictable demand.

For Metso as an OEM, the most difficult competitors in each segment of the consumables market are the multitude of specialized manufacturers rather than other OEMs \((M2; M6; M8)\). These niche competitors can be as advanced technologically and may have the ability to imitate and further develop OEM-manufactured consumables \((M2)\). The combination of increased competition and increased imitation has led to a trend of increasing commoditization of the consumables used in paper machines \((M5)\). This means that it becomes increasingly difficult to effectively differentiate original consumables from non-OEM consumables \((M2)\). As offerings have become more similar, buyers have been able to drive prices down through simple requests for quotation \((M11)\), thereby making the consumables aftermarket business far less lucrative for the OEMs \((M12)\).

More than just margins have eroded for the OEMs. The OEMs have lost a considerable share of the consumable market to the niche competitors, because, while buyers have become increasingly price sensitive due to the commoditization of the consumables \((M2)\), the niche competitors have been able to sustain significantly lower prices. Although their manufacturing costs are similar, the reason the niche competitors can compete on price is that they have lower overhead \((M2; M6; M10; M1)\), partially due to them being able to free-ride on the OEMs’ heavy R&D through spin-outs and employee attrition \((E1; P1)\). As an example of the pricing differences, consider doctor blades. Doctor blade suppliers are typically selected by paper companies on the basis of simple requests for quotation (RFQs), with the selection criteria being price per meter of blade \((M10)\). Niche competitors sporting lower overhead are able to profitably sell some types of doctor blades for, say, 200 euros per meter of blade, while Metso’s best offer would be priced 15–20% higher at 230–240 euros per meter \((M10)\). With such a price discrepancy, buyers will be strongly incentivized to select the non-OEM offering, regardless of the reputational advantage Metso holds as an OEM \((M5)\). In some blade types in Europe, Metso has lost up to 90% of tenders in this way; and even buyers who previously bought doctor blades from Metso have switched to lower cost suppliers \((M2; M5)\).

**METSO’S SALES STRATEGY FOR PAPER MACHINE CONSUMABLES**

One of Metso’s ultimate business development goals is to get pulp and paper companies to outsource the upkeep of the entire production line to Metso \((M8)\). In other words, Metso would like to eventually provide integrated solutions for keeping customers’ paper lines up-and-running. This market is very attractive for machinery suppliers \((M2)\), as full-service industrial maintenance contracts have less price transparency and better sales margins. A further step downstream would be to actually operate the machines on a daily basis. Such an arrangement could be a type of performance contracting, since it would make sense to pay the operator on the basis of actual paper
Appendix B: Focal supplier case study

production rather than using traditional cost plus or fixed price arrangements. So far, e.g. Metso has not functioned as such a “performance provider” in any paper mills (M2), and the concept remains more of an OEM’s dinner table envisagement than an actual business proposition.

A strategic repositioning towards service business has been difficult and sluggish, because Metso has traditionally been a product-focused technology company, where “90% of development efforts are spent on polishing products” (M2; M8). Another major hurdle is that paper mills currently have little if anything to gain by committing to a single machinery OEM for aftermarket services (M2; M11). In the meantime, Metso has placed developmental focus on trying to secure single supplier contracts in high-volume machine consumables (M2; M4; M5; M12). This means competing head-on with niche manufacturers, to whom Metso will generally lose on a price basis.

In line with the corporate strategy emphasizing service business expansion, Metso has, with limited success so far, tried to differentiate their consumables offering from the niche competitors and motivate their price premium by including free supplementary services such as tech support, inventory management and regular process audits in contracts (M5; M10; M11). By bundling the core product with supplementary services in this way, they try to differentiate and market themselves as a “solution provider” that helps customers improve their productivity, efficiency and quality (M2; M10). The rationale behind this value-added strategy is that Metso, as an OEM, has deep machine and process know-how that can be used to improve customers’ paper production processes beyond what they could accomplish by themselves (M2; M6; M11), while niche competitors aren’t able to provide such services at the same level (M5). However, there is a risk that the free services superficially disguise (rather than solve) low product profitability (M5).

Another differentiation avenue that was being explored by Metso is the bundling of multiple types of consumables into the same contracts. This would mean an all-in-one supplier contract comprising the three major consumables of a paper machine in terms of long-run replacement costs (see Figure 4). Niche competitors cannot offer such a bundle, because they are only capable of manufacturing one or two of the three parts (M2). For such a bundle to make sense from a buyer’s perspective, it must confer some added advantage over buying the parts separately at lower prices from specialist suppliers. The rationale behind the bundling is that the parts are in direct physical interaction in the paper machine, and it might be possible to lengthen their lifespans or improve process performance by optimizing the compatibility of the consumables as a system at

Figure 4: Simple representation of the “big three” paper machine consumables

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![Diagram Figure 4](image-url)
the design stage, rather than retrofitting parts from different manufacturers\(^{(M5; M7; M10; M11)}\).

**STRUGGLE TO DEMONSTRATE VALUE**

Metso’s competitive position in paper machine consumables is one of higher price and higher value—which stems from delivering bleeding-edge OEM technology and providing free supplementary services. To convince customers that Metso’s offering is worth the higher price, sales people tend to rely on slideshows with qualitative bulleted lists of benefits, e.g. using statements such as “we provide process support to reduce paper sheet breaks”\(^{(D8)}\). These types of sales pitch tactics were however considered rudimentary by managers, who contended that they should somehow be able to quantify the benefits of the offering in monetary terms, but had failed to do so because of a lack of good metrics and calculation methodology\(^{(M2; M4; M5)}\). For instance, a doctor blade might have a slightly lower coefficient of friction than competitors’ blades (other things being equal), but the energy savings are not normally verifiable through power use readings on the customers’ site, because the effect is too small to detect on a multi-megawatt machine drive\(^{(P1)}\). Similarly, it is not straightforward to determine how supplementary services like process audits impact the customer’s bottom line.

As Metso has been unable to unequivocally demonstrate the value of their high-price offering, they are in a disadvantageous position when customers put consumables contracts out to tender. The reason is that differences in value are difficult to ascertain whereas differences in price are not. When the buyers are professional purchasers in a central purchasing unit (rather than local mill management), this effect is exacerbated by an incentive problem called “green money vs. gray money”\(^{(Anderson et al. 2007, p.4)}\). *Green money* refers to cost savings for which purchasing managers can readily get credit, whereas *gray money* are cost savings that are difficult for purchasing managers to claim. Purchasing managers are thus incentivized to favor green money over gray money when making sourcing decisions. When purchasing consumables, an example of green money is volume discounts, because these are directly attributable to the negotiating prowess of the purchasing manager. This is demonstrated in cases where purchasing managers have explicitly asked Metso’s salespeople to first state higher list prices and then lower the price by 20 %, just so that the manager could report to his or her superior that a 20 % discount was negotiated\(^{(M9)}\). Gray money on the other hand includes cost savings generated through e.g. increased machine reliability, which is hard to measure in aggregate and even harder to attribute to a particular consumables contract.

As product specifications become more similar and price competition increases, it makes sense to motivate a higher price by emphasizing any technological edge available and bundling the core product with supplementary services designed to lower the customer’s overall costs. The odds are nevertheless stacked against a MRO supplier taking this route, because procurement managers are focused on securing tangible price savings rather than guessing the benefit of cutting-edge product characteristics or bundled services. Total cost of ownership analysis can even the playing field *vis-à-vis* low-price suppliers, because the method entails objectively quantifying the *total* costs associated with an offering, and thus turning “gray money” to “green money”.

**TRIGGER OF THE SELL-SIDE TCO INITIATIVE**

In 2010, the central procurement of one of Metso’s largest customers issued an A4-sized paper termed “Total cost of ownership (TCO) business opportunities”\(^{(D4)}\). This paper was a simple bulleted list of various ways that MRO suppliers could reduce the total costs for the customer\(^{(D4)}\).
For instance, the customer noted that total life cycle costs related to consumables and spare parts could be reduced through energy savings, productivity programs, and product life extension (D4). This was quickly recognized by Metso’s sales managers as a list of ways to differentiate their consumables offering from the niche competitors, and the “TCO” acronym subsequently caught on at Metso (M2; M3; M5; M8; M11). Inspiration was drawn from Sweden’s bearings manufacturer SKF, which used total cost of ownership as a metric in its “Documented Solutions Program”—a systematic effort to document the value added delivered to the company’s customers (Snelgrove 2008). SKF’s freely available sales materials were circulated internally at Metso, with the aim of adopting concepts already known to work.

[Paraphrased from Finnish]
« We need to conceptualize the consumables business so that it stops being a business where somebody sits by the fax machine awaiting orders. We continuously get calls or e-mails from customers where they list specifications of what they need and then ask for the price tag. Do the customers really want to buy stuff from each product group on a different occasion every week or month? Couldn’t they instead commit to a single supplier contract with Metso where added value comes from consignment inventories and training? We need to create an attractive offer. TCO offers a great way of doing this. »

~ Director, Roll Covers

The next year, in 2011, Metso launched a TCO business development initiative. Unlike ordinary buy-side TCO initiatives (Wouters et al. 2005), Metso’s initiative was occurring sell-side. Talk and rudimentary development started on “TCO models” (i.e. spreadsheet calculators of life cycle cost savings), “TCO elements” (i.e. supplementary services designed to lower the customers total costs) and “TCO contracts” (i.e. supplier agreements that include multiple “TCO elements” and whose pricing or sales argument is based on a “TCO model”) (M5; M8; M10). Some old ideas were renamed in terms of this terminology, e.g. a pay-by-use pricing scheme for paper machine clothing was referred to as a “TCO concept” (D5). This flurry of activity led to semantic confusion among sales and general managers regarding the meaning of the term “TCO” and how it related to existing notions of “package deals”, “solutions” and “supply contracts” (M10), in addition to the “classic” mix-up with value-based pricing (Liozu et al. 2012). Nevertheless, this appeared of little concern as a business unit manager shrugged it off saying “we enjoy 3-letter abbreviations” (PR5).

Although the three letter “TCO” acronym had become an ambiguous buzzword in the company, the logic behind its use was clear to the few managers familiar with the formal definitions for total cost of ownership. They reasoned that Metso, as a paper machine OEM, understands the total costs associated with machine consumables better than the paper companies buying them, because paper companies are focused on what comes out of the paper machine rather than what goes on inside the machine (M2; M7; M11). At Metso, managers believed that the customers’ lesser understanding of the total costs, particularly among non-technical purchasing professionals, biased the customers towards buying low priced consumables and not sufficiently accounting for indirect cost elements such as energy costs (M5; M10). None of Metso’s customers were known to utilize formal TCO analysis for selecting MRO suppliers; not even the large customer that originally suggested opportunities to reduce total costs. Yet the implicit view among Metso’s employees was that if the customers were to do such calculations in a rigorous fashion, they would find that Metso’s higher priced consumables offering would in fact have the lowest TCO among all consumable suppliers. Therefore, the argument goes, Metso could argue that it is the best supplier by performing the TCO calculations proactively for the customer (M2) and thereby getting...
customers to focus on total costs in the long run instead of just looking at the sticker price $^{(M5; M10; M11)}$. 

APPENDIX C: CUSTOMER CASE STUDY

The purpose of the customer case study was to explore the business context of Metso’s TCO initiative from a customer perspective and thus identify obstacles to the sell-side use of TCO analysis. This was done by aggregating and comparing six embedded subcases—one for each of the surveyed customer companies in the pulp and paper industry. Each subcase consisted of at least one (group) interview, for a total of ten semi-structured interviews with a total of 16 interviewees (as listed in Table 1 on page 4). Through these interviews, altogether six obstacles to sell-side TCO analysis were identified.

This section is structured so as to substantiate and accentuate each obstacle identified. First, a general introduction to paper industry MRO sourcing is provided, along with a description of the decision making unit (DMU) for corporate framework agreements for paper machine consumables. Then, corporate-level and mill-level supplier selection methods and criteria are separately discussed. Thereafter, a real buy-side TCO analysis is examined, and a few key cost drivers missing from the analysis are considered. Finally, some alternative notions of “TCO” are scrutinized.

As in the focal supplier case study, all interviewees are cited using shorthand superscript notation, e.g. (Z1). The full list of customer interviewees is provided in Table 1 on page 4.

INTRODUCTION TO PROCUREMENT OF PAPER MACHINE CONSUMABLES

Pulp and paper companies manufacture paper by grinding and dissolving wood and recycled paper into pulp, which is pressed and dried in a paper machine to become paper. The paper produced is sold in large batches to publishers, converters and printers, who subsequently process the bulk paper into end products. In Europe and North America, the industry has been characterized by low profitability since the late 1990’s, which has led to mill shutdowns, workforce reductions and other cost cutting initiatives (Uronen 2010, p.68; Diesen 2007, pp.15, 118–119). While some functions such as maintenance have been partly outsourced to OEM’s and third parties, the daily operation of the production lines has universally been designated a core competence (Z1; U1; S1; B1; E1; P1).

To achieve economies of scale and scope, the pulp and paper industry has become increasingly consolidated through mergers and acquisitions (Diesen 2007, p.121). As business functions have been centralized, the nature of individual paper mills has changed from being independent profit centers into cost centers responsible for production only (Z1; U3; B1). Paper mills are no longer evaluated based on profit, because regional sales offices have taken over the responsibility for the sale and marketing of paper (U3). Instead, the key metrics for mills are tons of paper produced, costs per ton of paper produced, production schedule compliance and paper quality (U1; U2; U3; B1). Thus, when schedules and quality standards are being met, mill management will be concerned with optimizing the trade-off between minimizing costs and maximizing the production of paper.

A considerable cost element for paper mills are MRO supplies and services. In a newsprint mill, for instance, MRO may account for roughly 10% of variable costs (Diesen 2007, p.150). This figure excludes considerable amounts of in-house maintenance labor, which is a fixed cost in the short term. Generally speaking, paper companies tend to involve maintenance contractors

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10 Production schedule compliance is a monthly metric of how well the mill is complying with the corporate-level master production schedule containing the exact grades and quantities of paper that need be produced. (P1)
only during outages and in emergencies\(^{(Z1; U1; S1; B1; P1)}\), despite such full service maintenance being offered by OEMs and qualified third party maintenance companies.

« [You need] own expertise in your home, in your house, and in your organization. [...] If you would outsource [all] maintenance for example, you will lose [that] expertise. [...] [Then] you [will not] have the people who are able to discuss on the same level with the supplier. I [would] have to believe everything the supplier proposes to me. And, therefore, most people I know in the German paper industry are not so keen to go that way, [which] makes it so difficult for Metso or for Voith to find paper companies to go together with them this way. »

~ Managing director, Papierfabrik Palm

Like the procurement function in general, MRO procurement has become increasingly (although not fully) centralized over time\(^{(U1)}\). Broadly speaking, the procurement function in large paper companies is organized in two different processes. On the corporate level, there is a central (world-wide) and/or multiple regional (continent or country) buying organization(s) responsible for negotiating and administering multi-year framework agreements in various high-cost MRO categories such as paper machine clothing and roll covers\(^{(Z1; Z2; U1; S1; B1)}\). This allows the company to save on transaction costs\(^{(B1)}\) and achieve a stronger negotiating position versus suppliers and thus bargain for lower prices and better terms on warranties, delivery and payment\(^{(U1; S1)}\). The framework agreements typically either recommend or dictate certain volume distributions among preferred suppliers, based on aggregated opinions from the company’s paper mills\(^{(Z2; U2; U3; S1)}\). On the mill level, local purchasing agents such as material planners carry out day-to-day purchase order requests based on local needs, mainly by referring to existing framework agreements, but sometimes through mill-specific contracts of their own making\(^{(Z1; Z2; U1; U3; S1; B1)}\). Although central procurement may have formal authority in approving procurement decisions, in practice the decision ultimately rests with mill management and operative personnel because they may have cogent technical and logistical reasons for using a particular supplier\(^{(U1; U2; S2; P1)}\). As a rule however, mills tend to have high framework agreement compliance rates, because they are supposed to honor corporate-level decisions\(^{(U1; U2; U3; Z2)}\), so suppliers obtain the sales volumes (if any) promised in the framework agreements\(^{(S1)}\). This can however lead to added costs in some mills, because changing suppliers in accordance with new framework agreements may inadvertently induce considerable switching costs. For instance, a production director noted that changing felt suppliers may necessitate doubling the felt replacement frequency (and thus direct costs) for six months until the optimal fabric from the new supplier is identified\(^{(U3)}\).

From a MRO supplier’s point of view it is critical to succeed in the framework agreement negotiations, because this is where the deal is made and volumes are allocated. Being selected as a preferred supplier and allocated high volume does not entail merely persuading commercially oriented corporate buyers of the superiority of the supplier’s offering, but also convincing the technical paper mill staff that central procurement is reliant upon for product and service evaluations. Confusing these two by making a technical presentation for a corporate buyer will not yield the desired results. As a purchasing director accounted:

« A supplier’s sales person and his boss came over to us [a while ago].

\textit{Seller}: “With this new [forming] wire, you will be getting less markings on your paper. Look at this graph. This is how much markings you had before, and now you’d only have this much markings.”

\textit{Buyer}: “Oh, how much for the wire then?”

\textit{Seller}: “Well, it’s just 5 percent more [than you’re paying now]”

\textit{Buyer}: “Do I get more money for the paper I’m selling then?”

\textit{Seller}: “No”
Buyer: “Can I produce more then?”

Seller: “No”

Buyer: “Then why should I buy it?”

The guy didn’t have a good answer to this question.

If they come and show me, “now we’re weaving [the fabric] this way, so that the threads are laid out like this”, then it’s a waste of my time because I am not interested in how the fabric is produced, only in its cost versus its performance. However, if they show this to the production manager or operating engineer, they might find it useful and might help the supplier getting a trial. »

~ Purchasing director, Stora Enso

The ensemble of people involved in any given procurement decision in the customer company is the decision making unit (DMU) for that decision. Every member of the DMU has a particular role, such as the initiator who suggests the deal, the influencer who has a say on what to buy, the decider who says yes or no, and the user who ends up using the item bought. Table 7 shows these roles for the decision to establish a framework agreement for paper machine consumables. This generalization applies across all large paper companies surveyed and to all consumables within the scope of this study \((Z_1, U_1, U_2, S_1, B_1, E_1)\). A slight deviation is that roll covers additionally involves maintenance staff as initiators and users, because paper machine rolls are maintained through cover grinding and e.g. vibration analysis \((U_1)\). All in all, the DMU can contain anything from several to tens of people.

Note that the DMU does not contain the mills’ local purchasing agents in a buyer role, because the operational process of purchasing consumables in mills is subordinate to the corporate-level process of deciding framework agreements. Machine consumables are straight rebuys for mills, as they need to be regularly replaced in the paper machine, oftentimes within weeks. Consequently, mills tend to handle replenishment through multi-year annual requirements arrangements, in which a supplier agrees to supply all or a portion of the buyer’s annual requirements for a specific item at an agreed upon price. A doctor blade supply agreement, for example, may be worth anywhere from 50 000 to 300 000 euros annually per paper machine \((D_6, D_9)\). Such contracts must abide by existing framework agreements, thus making the mill purchasing process largely a clerical routine where inventory is replenished through submission of simple release forms to suppliers.

All consumables are paid from the mill cost centers. Budgets are either set by central procurement and rolled out to the mills (as in UPM), or the mills independently make their own budgets (as in Stora Enso) \((U_2; S_1)\). Doctor blades and paper machine clothing are generally paid for from mills’ operational budgets, while roll covers are paid from the maintenance budget \((Z_1; U_1; U_3; E_1)\). Major modifications of the consumables and their fitting (e.g. blade and rod holders) in a ma-

<table>
<thead>
<tr>
<th>Initiator</th>
<th>Influencer</th>
<th>Decider</th>
<th>User</th>
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<tbody>
<tr>
<td>MRO buyer(s) responsible for the particular category of consumables</td>
<td>Mills’ production managers and operating engineers (and maintenance manager for roll covers). Support functions such as finance may be involved.</td>
<td>Category team consisting of MRO buyer(s) and a few select production managers and operating engineers from mills. Major deals in machine clothing may involve mill managers and corporate vice presidents.</td>
<td>Mills’ operating staff (and maintenance staff for roll covers).</td>
</tr>
</tbody>
</table>
machine may be considered capital investments, in which case they are paid out of a separate mill capital budget (Z1; U3; B1; E1). At UPM, for instance, single investments over 30 000 euros were classified as capital expenditures and required a pay-back time of less than a year (U3).

**CORPORATE-LEVEL PURCHASING STRATEGIES FOR PAPER MACHINE CONSUMABLES**

All paper companies surveyed wanted to reduce the price of their paper machine consumables by driving down suppliers’ margins. The companies did this to a large extent by employing a competitive negotiation strategy, which entails creating an atmosphere of aggressive price competition through competitive bidding and threats of substituting existing suppliers (Z1; U1; S1; B1; E1; P1). To increase price transparency, the paper companies used other pricing metrics in addition to or in lieu of euros per item. For doctor blades, the standard was euros per meter, whereas machine clothing was commoditized using €/m², €/kg or €/t-count (number of threads per cm²) (U1; U2; S1; E1). The payment terms (cash in advance or deferred payment) were in some companies converted directly into a monetary value based on the company’s cost of capital (U1).

In the large paper companies, this strategy was leveraged by issuing RFQs (requests for quotation) and RFPs (requests for proposal) to establish framework contracts for product categories across multiple mills, which would increase suppliers’ incentives to undercut normal prices in the hopes of winning a big contract. A supply manager at Stora Enso noted that using this strategy for machine clothing, they had been able drive down suppliers’ margins to an estimated 7–8% during the last few years, and expected that margins could only be squeezed by a further 2–3 percentage points in the long term (S1). The competitive negotiation strategy was further emphasized in some companies by providing procurement professionals with financial incentives to come out on top in negotiations. For example, UPM used some performance-based pay for its central sourcing staff, based upon year-on-year price reductions and other clear-cut savings (U1). On the other hand, a buyer at Zeta argued that such incentive systems are dangerous, stating that “we get no bonuses for performance—we get to come back and work here the next day” (Z1). The existence of performance-based pay possibly exacerbates the “green money vs. gray money” problem discussed on page 29, because it places focus on easily measurable proxies for value, e.g. price.

Through the competitive bidding processes, the paper companies usually selected three (sometimes two) preferred suppliers in each category and ranked them based on their performance in the bid (U1; S1; S2; B1; P1). Volumes, if allocated, were typically set using a fixed distribution, commonly e.g. 60–30–10, where the smallest supplier had a backup or trial status (S1; S2; B1; P1). The limitation on the number of suppliers can be seen as part of a supply base rationalization strategy. UPM, for instance, had an explicit strategic goal of reducing the number of suppliers downwards from 20 000 (U1). Even though rationalizing the supply base can enhance customer-supplier relationships and reduce transaction costs, none of the surveyed paper companies mentioned having sole supplier framework agreements for the studied machine consumables, although Stora Enso was planning on making single supplier contracts for multiple consumables on a few old and optimized cash cow machines in Sweden (S2). The reasons why buyers generally favored multiple rather than single suppliers were threefold: (1) it reduces the buyer’s risk by having a surefire alternative in case the primary supplier fails to deliver (Z2; U2; S2), (2) the buyer is more quickly informed of technological developments as suppliers strive to increase their volume (Z2; U3; S1; S2; B1; P1); and (3) the threat of other field tested suppliers increases the buyer’s bargaining power when contracts expire (B1; P1).
Table 8 contains the surveyed companies’ selection methods and criteria for selecting the primary preferred supplier (and subsequent suppliers) in framework agreements for paper machine consumables. All companies used one of the following two basic methods: (a) pick the supplier with the lowest bid price among a set of qualified suppliers, where the pre-qualification is based on mills’ subjective experience and technical assessments; or (b) pick the supplier with the highest overall score in a (linear) weighted point plan \((Z_1; U_1; U_2; S_1; S_2; B_1; E_1)\) — a method which entails subjectively assigning weights to different qualitative and quantitative criteria, ranking suppliers on those criteria, and finally multiplying the rankings and weights to arrive at the overall score. None of the buyers reported using more sophisticated supplier selection methods, such as total cost of ownership analysis, mathematical programming or statistical models.

Table 8: Outline of preferred supplier selection methods and criteria for world-wide or regional framework agreements for paper machine consumables.

<table>
<thead>
<tr>
<th>Company</th>
<th>Selection method</th>
<th>Selection criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boise</td>
<td>Weighted point plan</td>
<td>The main determinant was the cost of the product fully delivered, i.e. the total cost of acquisition (but not use). Other determinants included supplier technology and reliability, warranties &amp; technical support, payment terms and effects on machine efficiency and cost of maintenance and inventory. For roll covers they looked specifically at lifetime, repair cycle time and repair shop proximity; for clothing it was lifetime and drainage.</td>
</tr>
<tr>
<td>M-real</td>
<td>Lowest price among qualified suppliers</td>
<td>Quality, lifetime and energy issues were accounted for on a case-by-case basis. Machine clothing suppliers in different machine positions had been evaluated a few times through a mill survey, where each supplier had been scored on a 1–5 Likert scale in six areas: price, quality, reliability, experience, service, communication and flexibility. The supplier with the highest average could sometimes be selected over the lowest price bidder.</td>
</tr>
<tr>
<td>Papier-fabrik Palm</td>
<td>Lowest price among qualified suppliers</td>
<td>Price was the primary determinant. They sought contracts with as little supplementary services as possible. Higher priced offerings were only selected in rare cases for technical reasons.</td>
</tr>
<tr>
<td>Stora Enso</td>
<td>Lowest price among qualified suppliers</td>
<td>Suppliers were qualified based on their financial status, along with their capability and delivery reliability in 800 different machine positions. Mills could suggest changes to volume allocations set by central purchasing, typically for reasons related to total cost.</td>
</tr>
<tr>
<td>UPM</td>
<td>Lowest price among qualified suppliers or Weighted point plan</td>
<td>Oftentimes lowest price and best payment terms among qualified suppliers (based on supplier capability). For paper machine clothing: 45% weight on commercial analysis (price-level, customer service, strategic fit, terms of payment, automatic invoicing in SAP), 55% weight on technical survey (local technical support and problem solving). Mills had the final say in what supplier they used, based on lead-time, delivery accuracy, consumable lifetime, safety and effects on machine efficiency, capacity utilization rate, sheet breakage and energy use.</td>
</tr>
<tr>
<td>Zeta</td>
<td>&lt;not disclosed&gt;</td>
<td>A combination of price, technical service, reliability, financial strength and lifetime performance (overall machine effectiveness, downtime, life cycle length, predictive maintenance). The criteria were evaluated using consumption data, field reports, and information provided by suppliers. Technical requirements were evaluated by a separate technical team.</td>
</tr>
</tbody>
</table>
Even though none of the paper companies reported formally using total cost of ownership analysis in procurement, the notion of total cost was nevertheless well understood. A production director at Stora Enso noted that “TCO is what matters to me. If I’d have a TCO breakdown in euros for every supplier in every machine position, then it would be very easy for me to distribute volumes among suppliers […] But I don’t think you can have a huge fancy Excel model [to do this, so I] rather use gut feeling and common sense” (S1). This type of total cost thinking was implicit in how all DMU members considered sourcing decisions. All interviewees demonstrated awareness of important hidden costs drivers associated with machine consumables, including machine downtime (U1), paper broke (quality defects) (U1; S1), energy use (S1) and lifecycle length (U3; S1; B1). But because of the considerable effort involved, such hidden costs were rarely quantified and almost never combined to produce a total cost figure (U1; B1).

**Mill-level procurement decisions**

While paper companies’ central procurement was concerned with the formal negotiation of corporate-wide framework agreements for paper machine consumables, every paper mill still bore ultimate responsibility for what suppliers to use, what consumables to run, and what investments to make. Mills were authorized to select suppliers by their own accord in product categories where no framework agreement existed, although they oftentimes consulted with central procurement, whose staff could help with bargaining and analysis. There was also leeway to test new products and services and even permanently introduce exceptions to framework agreements for paramount reasons (S2); e.g. technical compatibility.

Neither management nor operating staff reported using formal total cost of ownership analysis to decide on purchase order requests and sourcing decisions (U3; S2; E1; P1). Instead, decisions were made informally, mainly based on lowest price and whether the product was known to fulfill technical performance expectations (U3; S2; E1; P1). The notion of hidden costs was well understood, but they were seldom quantified due to reasons discussed later on pages 42–45.

Paper mills’ substantial influence on purchasing was understood by suppliers, who recognized the possibility of making additional mill sales outside of any existing framework agreement. Accordingly, suppliers’ sales persons oftentimes approached individual mills directly, without going through central procurement. From mill management’s perspective, the only way to determine the truthfulness of suppliers’ sales arguments was to conduct a trial (feasibility study) on the machine where the consumables were supposed to be installed (U3; S1; E1).

The reason why trials were necessary was that paper machines are both unique (what worked on one machine is no guarantee that it will work on another similar machine) and complex (overall effects of new parts cannot be predicted from first principles). Doctor blades for instance, a managing director noted: “… you can have a similar design on a press felt, but number 1 is working and number 2 is not working. […] Nobody knows exactly why.” (P1). Consequently, a supplier cannot show up with theoretical TCO calculations in a sales pitch and expect customers to buy anything based merely on those calculations. One supply manager reported that a supplier had suggested an upgrade of their sheet metal doctor blades to a much more expensive energy-saving model. Based on some detailed Excel crunching, the supplier had told them they would save 200 000 euros in total costs by installing the new high-tech blades. The supply manager was not convinced, but agreed to a trial where the supplier would deliver two weeks’ worth of blades for free. The claimed savings were not verified, and the supplier had to leave empty handed (E1).
[Paraphrased from Finnish]

“Every salesman says that their product saves energy and lasts longer based on tests in other machines, but nothing is a fact until a trial has been conducted on our machine. It’s up to us to assess whether a trial is needed and whether we believe that the supplier has the potential to become a large supplier for us in the future. A supplier can come and show us a TCO breakdown, but they can’t really show anything other than their own price breakdown without running a trial at our mill. And even then, we’d be very wary of revealing any details about our costs. You don’t want to go out on the street shouting about how much money we’d lose in a three hour outage, because that information could be used to deduce our financial outlook.”

~ Supply manager, M-real

While the quote above illustrates the necessity of objective mill-specific data for sell-side TCO analysis, it also shows how cautious publicly listed companies are of revealing operational profitability figures, even to their preferred suppliers. A company may fear knowledge drain to competitors, because suppliers could use the intimate information gained to improve competitors’ operations.

To secure a trial, a MRO supplier needs good references from similar projects on other similar machines, including as much technical facts and/or tangible examples as possible. In the words of a supply manager at UPM: “I quickly tell sales people and technical guys that ‘what our mill staff likes and what we like, are references. [...] And even better, UPM references.’ [...] If they don’t have a reference, then the sales presentation needs to have fewer superlatives and that kind of stuff, and more justifications [of how it’s going to work]” (U1). Getting the very first reference is the tricky part. In cases where a real pilot project is in question (i.e. no references available), the supplier may have to give considerable discounts or even some consumables for free. Even if discounts are given, mills do not easily participate in trials, because of the added work and risk involved. The business risk of the trials may require a formal review, and final approval may be sought from central procurement and senior management. A failed trial will worsen the mills’ key performance indicators, such as machine efficiency or production schedule compliance. At Boise they had solved this problem by assigning accountability for failed, corporately condoned trials to a corporate development function. Suppliers however, are unable to provide a similar de-risking service, because offering discounts, freebies or even straight cash won’t save face nor will it restore blemished KPIs in the case of a failed trial.

USE OF TOTAL COST OF OWNERSHIP ANALYSIS IN PAPER COMPANIES

As already established, none of the paper companies surveyed reported using total cost of ownership analysis (as defined on page 5) for MRO supplier selection or otherwise, with the exception of a few sporadic analyses made by purchasing managers at UPM. Nevertheless, most purchasing managers demonstrated some degree of familiarity with the method when shown a conceptual TCO breakdown. In particular, a few noted that TCO was similar to breaking down the supplier’s price into cost components.

Example: Total cost of ownership analysis of a press felt

To see how buy-side total cost of ownership analysis was used in a paper company, a real example is provided in Figure 5 below. Figure 5 shows the final result of a single, one-off TCO analysis (including a price breakdown) conducted on a particular supplier’s press felt (a high-cost, short lifecycle piece of machine clothing). The analysis answers three basic questions: (1) How
much total costs (TCO) will the paper company incur when buying one press felt from this particular supplier? (2) What are the main cost drivers behind the total cost, considering both the company’s internally generated costs and the supplier’s costs driving the price? (3) What is the supplier’s profit margin?

For illustration, assume the felt costs 50,000 euros per unit. Based on the TCO analysis, the answers to the questions above are: (1) Buying the press felt generates 100,000 euros in total costs per unit, which is twice the price of the felt; (2) The main cost drivers are direct labor in the supplier’s felt factory and production downtime in the paper mill due to felt change; and (3) The supplier’s profit margin is about 10%. These facts could then be used by the paper company to make a more informed sourcing decision and to provide areas for negotiation beyond price.

To understand how the TCO breakdown in Figure 5 was constructed, we need to look closer at how the costs were calculated. Notice that Figure 5 consists of two parts. First, on the left hand side is the supplier’s price decomposition—figures that have either been provided by the felt manufacturer voluntarily, or independently estimated by the paper company. From the supplier’s point of view, the price decomposition is a profitability analysis, because the product margin has been calculated. To do the analysis, the supplier would either have used traditional absorption costing or more sophisticated activity-based costing. Second, on the right hand side of Figure 5, is the total cost of ownership calculation from the paper company’s point of view. Here, the paper company has identified four activities they perform to acquire and use the press felt: administration, logistics, installation and downtime. The sum of all these costly, attributable activities, plus price of the press felt, is considered to be the total cost (TCO) incurred by the company. As an example of the cost estimates used, Table 9 shows, on a general level, how the costs of installation labor and downtime were estimated. Note that both are based on activities (installation and shutdown time) in accordance with the principles of activity-based costing.

<table>
<thead>
<tr>
<th>Cost element</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation labor</td>
<td>Average number of workers required for installing the felt × Average hours per worker required for installation × Cost of installation work (EUR/hour)</td>
</tr>
<tr>
<td>Downtime</td>
<td>Average duration of a planned shutdown (hours) × Share (%) of planned shutdown duration due to press felt change, (depends on, e.g., operating rate, cleaning, maintenance and other reasons). × Paper machine contribution margin (EUR/hour)</td>
</tr>
</tbody>
</table>
Figure 5: Total cost of ownership breakdown of a press felt.\(^1\)

\(^1\) This TCO breakdown is published with permission. To maintain confidentiality, no scales are shown and the figures are fictitious (although representative).
The reason downtime is responsible for large fraction of the TCO is that the paper machine needs to be shut down for 4–8 hours when installing the felt, which means forfeiting a contribution margin of thousands or even tens of thousands of euros per hour depending on market conditions \(^{U3; S2}\). Downtime however is actually an opportunity cost (a revenue-side effect), since it represents contribution margin forgone\(^{11}\). It is \textit{not} a cost that would be visible as an expense on the income statement, but rather its effect on the income statement would be a reduction in revenues (less paper to sell) \textit{and} a significant but smaller reduction in variable costs (e.g. due to savings in raw materials and energy). On the face of it, the large financial impact of downtime could also be an opportunity for suppliers to offer a quick installation service as part of a felt delivery contract. However, such a service was considered unfeasible by mill management and operating staff. The main reason was that having outsourced the activity, there wouldn’t be enough skilled personnel on-site around the clock, nor could the supplier’s people arrive quickly enough, to change fabrics in the event of a failed clothing trial or other unscheduled outage (which typically occur once in two months, vs. scheduled ones which occur monthly at most) \(^{U3; S2; E1; P1}\).

\textit{TCO as an extension of supplier price breakdown analysis}

Figure 5 on page 40 breaks down both the supply-side costs and the customer’s hidden costs—together constituting a supply-chain view of the total costs. Although not necessary for a TCO analysis, some buyers aimed to decompose the buyers price. At Zeta, they reported conducting price breakdowns (cost breakdowns) independently based on suppliers’ financial statements and market data \(^{Z2}\), to be used as tool for resolutely negotiating smaller margins with suppliers \(^{Z2}\). At UPM, on the other hand, the sourcing staff asked supplier’s sales people to voluntarily provide the cost structure for their products, by emphasizing open books collaboration to reduce the total costs in the supply chain \(^{U1}\).

« When talking about TCO-models, we need to really open all the cost drivers. From the end of the pipeline at the mill where the product is used, to the beginning of the pipeline where the product is manufactured. […] We need this type of thinking, but nobody [expletive] opens up the costs of their products [properly]. […] I believe that the supplier who figures this out and goes down this road will enjoy a big competitive advantage. In the end it doesn’t matter whether the margin is 100 percent or 300 percent as long as the price is competitive. Thank God and good for them if they have a huge margin, that’s always better. […] But nobody wants to open up their prices, because they are afraid that the discussion will inevitably turn to the magnitude of the margin. […] That’s not what I want to do at all. I want to discuss about how to drive costs down [together] so that the margin remains the same.[…] The tragicomic thing is, that [although we’ve managed to do a few fine analyses], we’ve never once, during my time at least, put a TCO model on the table together with the mill and the supplier and said: “Alright, let’s start thinking about how we can reduce this [TCO] for real”. »

~ Category manager, UPM

Some other interviewees were highly skeptical about supplier cost breakdowns being used for win-win purposes. At Boise, for instance, they argued that collaborative arguments like the one above are just a smokescreen for wanting to break down the margin \(^{B1}\).

\(^{11}\) The contribution margin (revenue less variable costs) was originally labeled “gross profit”. This is however misleading, because in accounting terms gross profit means revenue less cost of goods sold (COGS), where COGS contains allocated fixed costs as well. By definition, fixed costs do not vary with short-term changes in output; accordingly, contribution margin (or throughput) is the correct measure for the opportunity cost of downtime.
Measuring key TCO drivers for paper machine consumables

While uncomplicated and readily understandable for laymen, the example TCO analysis in Table 9 on page 39 has some shortcomings. First, it leaves out some key lifecycle cost drivers such as energy use and inventory costs. This means that the purported “total cost” is only a fraction of the true total cost of ownership, which should include all attributable expenses. Second, it fails to explicitly account for the useful life of the press felt. If the useful life were to change, then so would the replacement frequency, which in turn would mean a change in the annualized costs of consumables (S1).

The omission of these cost drivers is indicative of the difficulties in quantifying them. As it turns out, this applies not only to felts but to machine consumables in general (B1). Next, we discuss how useful life, energy use, and inventory costs were considered by buyers, and draw conclusions as to what this means for the feasibility of sell-side TCO analysis.

Useful life

By definition, all consumables gradually and visibly wear out due to friction, after which they have to be replaced. Simply put, the longer the useful life of a consumable, the less will be needed. For instance, if a high quality felt were to last twice as long as a standard felt, then felt-change intervals could presumptively be lengthened by a factor of two and the machine would require only half the number of felts. Such an effect was not accounted for in the example TCO analysis depicted earlier on page 40, where TCO was calculated per felt. To be able to compare the total cost of consumables with differing lifespans, it would apparently make more sense to compute e.g. TCO per year rather than TCO per consumable unit. Assuming a mill would run continuously, the formula for such a relationship would be:

\[
\text{TCO}_\text{Year} = \text{TCO}_\text{Unit} \times \frac{365 \text{ days}}{\text{useful life in days}}
\]  
(Eq. 2)

In real applications however, the formula above does not apply. This is because consumables can only be changed during machine shutdowns, but shutdowns cannot be performed every time a consumable is at the end of its useful life (S2). Rather, shutdowns must be minimized through careful planning, not only because they cause a loss of production, but also due to the much larger risk of component failure when the paper machine is restarted (U3). The shutdown frequency is a system dependent variable chiefly dictated by the consumable with the shortest useful life, namely some types of paper machine clothing that last for about a month (S2, U3, B1). Other consumables must be replaced in sync with this cycle time (or during unplanned shutdowns) and before they become a liability (U3, P1). This makes the predictability of useful life very important (U3, S2, P1). The useful life of a consumable is only an upper limit of the actual use time between installation and removal, which in turn depends on the frequency and length of planned and unplanned shutdowns. Case in point, long shutdowns dry and harden the dirt and deposits in the machine, which may necessitate replacing some of the clothing regardless of condition (U3, S2).

Any marginal increase in the useful life of a randomly selected consumable is largely worthless unless (a) it allows postponing replacement to a subsequent shutdown, or (b) the consumable in question is the bottleneck that constrains the entire shutdown cycle. The latter case is of particular interest (Z1), because lengthening the lifespan of the bottleneck consumable not only decreases annual TCO due to fewer replacements, but also directly decreases total machine downtime and allows optimizing the replacement of all other consumables based on the new, longer shutdown cycle.
In spite of the intricacies of optimizing consumables replacement, several of the procurement managers interviewed expressed interest towards measuring the lifespans of consumables, as the figures would give them some information about the relative performance of different suppliers (U2; S1; B1). UPM reported having implemented a corporate-wide reporting tool for monitoring clothing usage, comprising in-machine time and cause of removal (U2; U3). UPM’s tool was thus far limited to mill-level reporting and was unable to provide machine and position specific data (U2). Elsewhere, follow-up was only done locally at mills using simple spreadsheets (S1; B1; E1). A hurdle to making this information comparable was that the in-machine time of consumables depended on the wear rate, which in turn depended on capacity utilization and production speed (U3). One way of at least partly eliminating the prior factors is to divide annualized costs by the paper tons produced during that time, since the tons are proportional to both capacity utilization and production speed. Conceptually:

\[
\text{TCO}_{\text{Per ton}} = \frac{\text{TCO}_{\text{Year}}}{\text{Tons}_{\text{Year}}} = \frac{\text{Price}_{\text{Unit}} \times \text{Annual replacements} + \sum \text{attributable costs}}{\text{Tons}_{\text{Year}}} \quad (\text{Eq. 3})
\]

While TCO is a plain cost metric, TCO per ton of paper is a cost-efficiency metric since it is of the form input ÷ output. In cross-machine comparisons it is however still a flawed metric, because of differences in paper grades produced (B1).

[Paraphrased from Swedish] « I specifically care about cost per ton for felts. But we don't measure it centrally. We're currently implementing a report to collect the necessary data from each mill. Later on, it's going to be very easy to centrally calculate and compare how many tons we get on average from Voith's felts and how many tons we get from Metso's felts on the same machine. If we can produce 10% more with Voith's felts, then maybe they're worth paying a little bit more for as well. And vice versa. »

~ Procurement director, Stora Enso

With regard to sourcing decisions, the key observation here is that TCO (or just price) per ton is an appropriate selection metric only when the consumables can be tested on the same machine under optimal conditions. This implies making a pairwise comparison of the current versus the potential product (B1). If the new product allows more tons of paper to be produced at lower total cost, then it should be selected over the current product; all else being equal. A further inference is that since consumables are business critical items and must be sourced, only the TCO-per-ton difference between the current and the potential product matters. If the difference is negative, then the new product should be selected over the current one.

Energy use

The energy consumption of a paper machine depends on how effectively water can be pressed out of the wet paper slurry. An improvement in mechanical dewatering means that much less energy will be expended on evaporating paper moisture in the drying section of the machine. Paper machine consumables affect the dewatering efficiency and also impact energy use through the friction they generate. As it turns out, it is very difficult to empirically measure the energy consumption attributable to specific consumable, as paper machines are generally not equipped to accurately measure energy use by roll position (U2; U1; S1; B1; E1; P1).

This difficulty in measuring energy use is also reflected in the press felt TCO analysis on page 40, where energy use has been omitted as a TCO driver. Rigorous TCO analysis would neverthe-
less require the allocation of energy costs, because consumables of different quality may have differing dewatering and frictional characteristics. However, even if energy use could be locally measured by roll position using physical principles, it could still not necessarily be attributed to a consumable in the same fashion as gasoline expenditure can be attributed to a car. The reason is that while a car can be driven in isolation from other cars, paper machine consumables are coupled with the rest of the machine \((S_1, P_1)\). For instance, a center roll cover is scraped by a center roll doctor blade, whereby the resultant friction depends on the interaction between both surfaces. Consequently, there is no objectively defined chunk of the total electricity and steam bill that can be allocated to the use of a particular consumable. Rather, it is only possible to measure energy performance of a consumable using pairwise comparison with another consumable with the same function, e.g. a rubber suction press roll cover vis-à-vis a polyurethane suction press roll cover. In other words, only the \textit{differential} energy costs matter.

\textit{Inventory costs}

Consumables are generally made to order and may have delivery lead times of several weeks \((U_3; E_1)\). Combined with the possibility of sudden failures \((U_3)\), this forces paper companies to keep a safety stock of replacement consumables at each mill, which in turn means that a significant amount of working capital tied up in inventories of machine consumables. For example, Stora Enso and UPM reported having on-site inventories of machine clothing altogether worth tens of millions of euros and doctor blades worth millions \((U_1; S_1)\). A clothing inventory simply consists of several long wooden boxes containing one fabric each, typically two to four replacements per clothing position; \((U_3; S_2)\) whereas in a doctor blade inventory, the rolled-up blades are held in sturdy packages stacked in a mobile storage container near the paper machine \((D_11)\). For roll covers on the other hand, it is only necessary to have a single replacement roll with a new roll cover at hand for each roll position \((U_3)\).

Among other things, inventory carrying costs include storage costs, obsolescence costs and the opportunity cost of the capital tied up. From a total cost of ownership perspective, keeping consumables in inventory is an activity attributable to the future utilization of those items, wherefore inventory costs must be included as a cost element in TCO calculations. However, if inventory costs are equal for all suppliers’ comparable offerings, then they are inconsequential for supplier selection. This would normally be the case due to the similarity of the products, were it not for some suppliers offering consignment inventory services. A \textit{consignment inventory} is a warehousing system that entails storing a stock of supplier-owned consumable machine parts in the paper mill and transferring ownership rights to the customer item-by-item as new consumables are needed in the paper machine \((M_2)\). From the customer’s perspective, consignment eliminates the risk of obsolescence and the opportunity cost of capital, because these are born by the supplier. Excluding warehouse space needed, the supplier also incurs most of the storage costs, because they handle inventory replenishment. Inventory levels are monitored by the supplier either through manual inspection, or, in the case of doctor blades, also through remote monitoring and RFID technology, which allows keeping the inventory properly stacked and invoicing only for blades removed from the container \((D_6-7; U_3)\).

The effect of consignment inventories on the papermakers’ total cost of ownership is a contested issue. At UPM, interviewees were divided as to whether the company should engage in consignment inventories \((U_1; U_2; U_3)\). At Zeta, buyers expressed indifference towards consignment inventories for machine consumables, remarking that while transferring inventory ownership to the supplier would reduce their net working capital, suppliers would never accept this unless they
recouped the inventory carrying cost in some other way \( ^{(Z1)} \), e.g. through higher unit prices or by separately invoicing an annual amount equal to a fixed percentage of the inventory value. On the other hand, managers at Stora Enso were in favor of consignment agreements \( ^{(S1; S2)} \).

One argument expressed in favor of consignment agreements was that even with equal costs of capital, it is cheaper for the supplier to hold the inventory because the value of the inventory is lower on the supplier’s balance sheet (due to cost-based valuation that excludes sales margin) \( ^{(S1)} \). However, while this appears to be the case from an accounting perspective, it fails to account for the supplier’s opportunity cost of holding rather than immediately selling finished products for cash.

Moreover, inventory capital charges should ideally reflect the market risk (obsolescence) of the inventory itself, rather than being based on the company’s weighted average cost of capital. This means that arguments for consignment inventories based solely on suppliers’ lower WACC are moot. In the case of a typical finished goods inventory consisting of custom-made consumables, the inventory is as probable to become obsolete regardless of who owns it, since there is only one paper machine in existence where the consumables can reasonably be installed. Therefore, the capital charge should be the same for both supplier and customer.

Summing up, inventory costs are part of TCO, but suppliers appear to be on equal footing in this regard. Even for consignment inventories, there is no simple rationale for how customers’ total costs are lowered. Any advantages in terms of inventory handling and efficient supply chain management must be considered on a case-by-case basis to generate what a sourcing manager would see as “a very concrete and believable [savings] calculation” \( ^{(Z1)} \). A production director suggested that such savings could realistically be based on e.g. machine clothing suppliers having a few variable-length fabrics in stock that could be very quickly fitted and run on several different paper machines \( ^{(U3)} \).

**ALTERNATIVE USAGE OF THE TERM “TOTAL COST OF OWNERSHIP”**

Although actual usage of TCO analysis was rare among paper companies, the word ‘TCO’ was nevertheless part of the industry lingo. ‘TCO’ held several mutually incoherent meanings and was equivocally used as by suppliers in sales pitches. Congruently with the definition of TCO used herein, ‘TCO’ could loosely stand for “capital equipment lifecycle costs”, commonly referring to the whole paper machine’s long-run costs of operation \( ^{(S2; B1)} \). Accordingly, a ‘TCO contract’ referred to a long-term MRO delivery contract or other agreement emphasizing or guaranteeing post-purchase process improvements \( ^{(Z1; S2; D10)} \). On the other hand, TCO’ was in some companies used in a specific sense inconsistently with the academic notion of TCO—i.e. the sum of the purchase price plus expenses attributed through activity-based costing (as defined on page 5).

Table 2 summarizes these findings.

Next, we will show how the alternative usage of the term ‘total cost of ownership’ reveals deficiencies in proper TCO as a supplier selection metric. Also, the competing nomenclature itself is argued to be an obstacle to the use of TCO analysis in sales.

**“TCO” reductions due to improvement projects**

The term ‘total cost of ownership’ was loosely understood by interviewees as “capital equipment lifecycle costs” or just “costs”. Generally speaking, the lower the TCO, the better \( ^{(Z1; U1; U2; S1; S2; B1)} \). For this reason, ‘TCO’ was oftentimes associated with process improvement projects, particularly with the estimation or documentation of the savings generated \( ^{(Z1; B1)} \). Basically, a “TCO reduc-
tion” could be any process-related benefit such as lengthening the lifetime of machine clothing or alleviating production bottlenecks, as long as the monetary impact could be quantified using some kind of formula \((Z; B)\).

An example of such an improvement project is given in Table 10. Here, switching to a new type drying fabrics has increased machine drying capacity, which in turn has made it possible to increase the reel speed (–throughput paper tons) by 1.7% \((D)\). In this particular market, there is more demand for paper than the machine can produce, which means that the surplus paper produced can be sold at normal prices. This keeps the contribution margin (revenue less variable costs) per ton of paper constant—a circumstance more the exception than the rule in markets with production overcapacity \((B; E)\). The added tons of sellable production are therefore straightforwardly translated into an additional annual contribution margin of 0.7 million euros, which is ratified as the “documented annual savings”.

Table 10: Example of a documented savings claim from increasing machine reel speed (figures are fictional but representative)

<table>
<thead>
<tr>
<th>Initial state</th>
<th>Reel speed increases by 1.7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight per square meter (kg/m²)</td>
<td>0.045</td>
</tr>
<tr>
<td>Reel speed (m/minute)</td>
<td>1524</td>
</tr>
<tr>
<td>Trim width (m)</td>
<td>8.62</td>
</tr>
<tr>
<td>= Maximum gross production (kg/minute)</td>
<td>591.2</td>
</tr>
<tr>
<td>Number of minutes in a day</td>
<td>1440</td>
</tr>
<tr>
<td>Number of tons in a kilogram</td>
<td>0.001</td>
</tr>
<tr>
<td>= Maximum gross production (tons/day)</td>
<td>851.3</td>
</tr>
<tr>
<td>Scheduled operating days per year</td>
<td>360</td>
</tr>
<tr>
<td>= Scheduled gross production (tons/year)</td>
<td>306 457</td>
</tr>
<tr>
<td>Percentage of machine uptime</td>
<td>90 %</td>
</tr>
<tr>
<td>Percentage of good quality produce</td>
<td>98.5 %</td>
</tr>
<tr>
<td>= Sellable production per year (tons/year)</td>
<td>271 674</td>
</tr>
<tr>
<td>Contribution margin per ton</td>
<td>€150</td>
</tr>
<tr>
<td>= Contribution margin per year</td>
<td>€ 40 751 138</td>
</tr>
<tr>
<td>Documented annual savings</td>
<td>€ 695 229</td>
</tr>
</tbody>
</table>
Appendix C: Customer case study

Figure 6: Outline of a sales tool that Boise’s central procurement staff suggested suppliers should use when presenting investment proposals.¹

¹ Using this waterfall chart, the supplier would show the customer the expected lifetime discounted cash flow (CF) impact of the capital equipment investment (retrofits, upgrades, new modules, major overhauls). The year-on-year positive cash flow drivers could be e.g. (1) energy savings, (2) added throughput from increased machine speed, and (3) the economic benefit of being able to run new paper grades. Offsetting cash flow drivers could be e.g. maintenance. The calculations would be based on data from the supplier’s existing customers and, where needed, any assumptions would be spelled out explicitly. Soft benefits such as improved safety could be shown and acknowledged separately as a bonus consideration, but would not be included in fact-based decisions due to their unquantifiable nature. (B1)

“TCO” of process improvement agreements

Paper mills are dependent on machinery suppliers for improvements of the paper production process. Identifying good investment opportunities and quick-win calibrations requires deep knowledge about the technologies used, so paper mills tend to regularly involve suppliers in conceptualizing new improvement projects by granting them machine audits (L3; S2; E1). These auditing services are generally provided by suppliers for free, because audits give the supplier access to mill personnel and detailed process data—critical for making a persuasive sales argument. In one of Stora Enso’s mills, for instance, they tried to systematize audits by inviting suppliers only once every six months to audit their machines based on a problem description sent to the suppliers four weeks earlier (S2). This way, they tried to get the suppliers’ most competent specialists over to the mill to generate multiple independent reports on machine performance and bottleneck locations; all without any guarantees of new sales to the suppliers (S2).

Another, more binding way of systematizing audits is a long-term process improvement agreement—colloquially “TCO agreement”. Under such an agreement a machinery supplier guarantees, in exchange for a high sales volume on consumables for one or multiple mills, that they will identify and help implement a minimum worth of process improvements on a customer’s paper machines (Z1). If the guaranteed savings are not fully realized before the contract expires, then the supplier has to reimburse the difference in cash or credit (Z1). From the paper companies’ perspective, the purpose of such an arrangement is to prevent complacency in established preferred suppliers by necessitating mill presence and diffusion of new innovations (Z1).
To identify the necessary process improvements, the customer allows the supplier to regularly audit the paper machine and suggest small improvement projects, which may require expenditure on the part of the customer. The improvements do not have to be related to the types of consumables sold, e.g. new doctor blade holders as part of a doctor blade supply contract (D9), but can rather be systemic changes such as increasing production speed (D3). Once a project is completed, both parties (e.g. mill controllers, machine superintendents and supplier sales representatives) sign a document ratifying the costs and results of the project (Z1). Finally, each project is assigned a “documented savings” value that central procurement counts towards the machinery supplier’s contractual obligation (Z1; Z2).

As an example of such an improvement project, consider the calculation in Table 11 (D7). Here, the machinery supplier has helped paper mill staff identify ways to halve the maintenance frequency of a paper machine roll by changing the type of roll cover used. This has halved the maintenance costs for that particular roll and thereby brought about significant annualized savings for the paper mill, due to less maintenance operations being needed (an external cost) and less own labor being needed to change the roll for servicing (an internal cost). The external costs are hard cost savings in the sense that they are verifiable from the company’s profit and loss statement. In this example, internal costs are assumed verifiable as well, which implies that all the released man-hours can be cut (which is not the case if employees are salaried (Z1; B1)). Consequently, the total cost of that roll has been reduced by 26 280 euros per year of use, assuming no change in the annualized cost of the new roll cover.

Table 11: Example of a documented savings claim from halving roll maintenance frequency (figures are fictional but representative)

<table>
<thead>
<tr>
<th></th>
<th>Before: Roll maintenance once a year</th>
<th>After: Roll maintenance every two years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of a maintenance operation</td>
<td>€50 000</td>
<td>€50 000</td>
</tr>
<tr>
<td>× Number of maintenance operations per year</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>= Cost of roll maintenance operations per year</td>
<td>€50 000</td>
<td>€25 000</td>
</tr>
<tr>
<td>Labor cost per hour for roll changes</td>
<td>€80</td>
<td>€80</td>
</tr>
<tr>
<td>× Man-hours to change a roll</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>× Number of roll changes per year</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>= Cost from roll changes per year</td>
<td>€2 560</td>
<td>€1 280</td>
</tr>
<tr>
<td>Total annual costs from roll maintenance</td>
<td>€52 560</td>
<td>€26 280</td>
</tr>
<tr>
<td>Documented annual savings</td>
<td></td>
<td>€26 280</td>
</tr>
</tbody>
</table>

A key part of process improvement contracts is the valuation and documentation of the savings generated. At Zeta, the standard project valuation method was to simply use gross realized savings from a twelve month period (Z1; Z2), corresponding to e.g. €26 280 for the project in Table 11. This valuation method ignores both the size of the investment and any savings realized after the twelve month period. For a typical improvement project with a payback time of less than a year but with a useful life of more than a year, the “documented savings” is therefore only a fraction of the project’s net present value. This means that Zeta ends up with more savings than guaranteed upfront by the supplier, thereby incentivizing mill personnel to cooperate with suppliers in implementing process improvements despite the money-back guarantee. This does not
mean that all good investment opportunities identified by suppliers will be approved, funded, and given credit for; because the capital allocation cycle is inflexible and mills have inherent resource constraints ($Z_1, Z_2$).

The fundamental consequence of this type of process improvement agreement is that it makes contract price *commensurable* with the guaranteed savings during framework agreement negotiations. In other words, it mitigates the “green money vs. gray money” problem discussed on page 29. In regular framework agreement negotiations for consumables, a supplier could try to offer free audits and promises of process improvements to improve the perceived value of their offering. Yet, the customer’s central procurement staff cannot quantitatively appraise such services, as a result of which they constitute gray money. Under a process improvement agreement however, the supplier *guarantees* a certain amount of monetary savings. The guarantee is both credible and measurable, since there is a mutually acceptable, systematic way of documenting the realized savings. Therefore, the guaranteed savings constitute green money. Note that ‘realized savings’ doesn’t necessarily mean true savings in a positivistic sense, i.e. an objective measurement using a combination of technical metrics and accounting techniques. Rather, it is just a mutually agreed upon, best guess monetary value, which may or may not be based on sound science.\(^\text{12}\)

At Metso and Zeta, they have depicted the commensurability in manner similar to Figure 7 (D10). On the left hand side of Figure 7 is the list price of the contract, i.e. the sum of the list prices for all individual products and services included in the contract. On the right hand side is a column labeled ‘TCO’ or ‘total cost of ownership’, which constitutes list price less discounts, rebates and “continuous improvement savings” (the savings guaranteed by the supplier).

**Figure 7:** Non-academic usage of the term ‘total cost of ownership’ in a corporate-wide, single supplier roll cover, roll maintenance, and process improvement agreement.

![Figure 7: Non-academic usage of the term ‘total cost of ownership’](image)

Operationalizing the right hand column as “total cost of ownership” is misleading for two reasons. First, it does not represent merely costs (in a P&L sense) because the savings guaranteed by

\(^\text{12}\) The savings documentation method used by Zeta bears semblance to North American industrial parts distributor Applied Industrial Technologies’ *Documented Value Added®* (DVA) service process developed in the 1990’s (Anderson et al. 2006, pp.121–123) and also Swedish bearings Manufacturer SKF’s *Documented Solutions™* program developed in the 2000’s (Anderson & Narus 2003, p.347). A key difference is that these companies used the documentation process for sales purposes rather than procurement.
the supplier can arise from revenue improvements rather than cost reductions. Second, it does not represent total costs, only costs of acquisition, because no overhead attributable to the contract has been allocated on top of the discounted price. To avoid confusion, this column is referred to henceforth as ‘TCOₓ’ to distinguish it from proper TCO.

From the supplier’s perspective, Figure 7 mostly resembles a pocket price waterfall, where the pocket price is the true revenue (net cash flow) received by the supplier after discounts and other bonuses are deducted from the list (and invoice) price. The difference between pocket price and the TCOₓ in Figure 7 is the guaranteed continuous improvement savings element, which is equivalent to a discount if and only if the supplier completely neglects to deliver the guaranteed savings. In such a scenario, TCOₓ would equal the supplier’s pocket price. On the other hand, if the supplier does deliver the guaranteed savings, then the TCOₓ is less than the pocket price, because the continuous improvement savings are not a revenue leak for the supplier. Note that the supplier does incur some unknown amount of expenses from the auditing and documentation activities, but that this should be smaller than the guaranteed savings to make the contract worthwhile.

From the customer’s perspective, TCOₓ is the direct out-of-pocket costs for the contract if the supplier completely neglects to deliver the guaranteed savings (because the reimbursement is equivalent to a delayed discount). This makes low TCOₓ desirable when performing supplier selection. However, if the supplier does deliver the guaranteed savings, then TCOₓ is an ill-defined metric for costs incurred by the customer. The reason is that it mixes transaction inputs with transaction outputs by confounding the contract’s pocket price with some of the eventually accrued benefits of the contract, namely the documented process improvement savings. The documented savings cancel out part of the pocket price and can even make TCOₓ negative if large enough. This may seem reminiscent of a profitability calculation, but TCOₓ is not a measure of profit either, because it neglects e.g. the benefit of the consumables themselves. Rather, TCOₓ is best described as a modified pocket price.
APPENDIX D: ABBREVIATED INTERVIEW QUESTIONNAIRE

The semi-structured, explorative customer interviews were guided by the questions below. Spreadsheet examples obtained from the focal supplier were used to facilitate discussion.

QUESTIONS ESTABLISHING SUPPLIER SELECTION CONTEXT

1) How is the operation and maintenance of your paper machines currently organized?
2) How are consumables for paper machines procured? What are the roles of the operating, maintenance and corporate central procurement organizations?
3) How are the different consumables financed?
4) Do you have a specific strategy or policy which guides consumable supplier selection? E.g. category management.
5) Has top management set specific targets for consumables procurement?
6) Do you look for the best prices, e.g. using metrics such as euros per meter of doctor blade, or do you have other key performance indicators such as consumable lifetime?
7) How do you evaluate the technical specifications of the consumables?
8) How are the supplier selection metrics connected to the buyer’s incentive systems or performance evaluation?

QUESTIONS REGARDING HIDDEN COSTS

1) How large are the hidden costs over the consumable’s lifetime compared to the purchase price?
2) Do you track and try to uncover hidden costs such as paperwork, delivery costs, installation costs, inventory costs, maintenance costs, energy costs, and costs due to consumable failure such as paper broke, downtime costs, and damage to machine components?
3) Have you used any form of total cost of ownership, life cycle calculations, value-in-use or other overall total cost methodology to select the supplier for any type of product or service (not necessarily consumables)? Such a methodology would examine all the direct and indirect costs over the life of the product/service.

The interviewee is shown a table of cost and revenue drivers derived from Ferrin & Plank’s (2002, p.25) compilation from 73 manufacturing organizations.

4) Mark all the drivers that you see deem relevant for consumables (doctor blades, roll covers and machine clothing). You can also add relevant drivers that are not in the table.
5) Which of the marked drivers do you pay the most attention to? Why?
6) Theoretically speaking, are these drivers measurable objectively in monetary terms using some key performance indicator or other metric?
7) Practically speaking, can the drivers be measured with reasonable costs?
8) What is it that makes the drivers hard to measure?

QUESTIONS REGARDING COST CALCULATORS

1) Would it be beneficial for you if the suppliers could give examples of the total hidden costs associated with consumables? [Demonstration of a TCO waterfall]
(2) Would it be beneficial for you if the supplier used some form of value calculator (e.g. spreadsheet) to calculate what the offering is worth? [Demonstration of roll lifecycle calculator]

(3) Should such calculators be simple or comprehensive?

(4) Should the value models be created together (both you and the supplier), or should both model the savings separately?

(5) Should the calculators be based around certain key performance indicators such as net present value, payback time, plant availability, maintenance cost (per ton), production cost (per ton), profit (per ton), OEE etc.? [Demonstration of contribution margin calculator]

(6) What do you think are the foremost challenges in making the value calculations believable to both parties?

(7) Should suppliers attempt to explicitly compare their offering against that of their competitors?

(8) In their sales pitches, consumable suppliers sometimes make cost savings claims that are hard to believe. How extensively would you be willing to cooperate with suppliers to determine the truthfulness of those claims? E.g. allowing machine audits to measure performance.