A Total Cost of Ownership Model for Global Sourcing

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Abstract: Global sourcing of electrical and mechanical components for manufacturing industry from offshore suppliers in Asia poses challenges for Western companies especially for small and medium enterprises. The expected cost savings can seldom be obtained due to additional transaction and opportunity costs that are not considered thoroughly. The approach of total cost of ownership facilitates a holistic analysis of cost objects. This paper presents a method for categorizing various cost objects of an integral TCO analysis, suggests an approach for identifying cost objects in enterprises and introduces a model for incorporating opportunity costs. The integration of monetary costs, transaction costs and opportunity costs into a holistic total cost of ownership model allows a transparent evaluation and comparison of several sourcing options.

1. Introduction

Supply chain management has strongly gained in importance during the last decades. While in the past companies from the manufacturing industry solely needed to satisfy their need for raw material and commodities, nowadays, they have reduced their vertical range of manufacture concentrating on core competencies. The increased importance has promoted the function of supply chain management to a key function even in small and medium enterprises (SME). Currently, the development of emerging markets forms new opportunities for global sourcing. Especially China has advanced to one of the most important supply markets for goods of the manufacturing industry with high volumes and with a significant share of labour costs. But there are more reasons for companies to spread their supplier base all over the world. In general, the main reasons for outsourcing are reducing costs of production factors, gaining access to new sales markets, ensuring flexibility and delivery, avoiding capacity shortages, taking advantage of foreign tax systems and subventions, and benefiting from the proximity to customers [1].

Explorative interviews with eight companies in Switzerland showed that global sourcing activities are characterized by pragmatic practices and that there is a need for analytic approaches to support decision making. In many cases, the expected cost savings of global sourcing projects due to lower labour costs are diminished by hidden costs [2]. The theory of transaction costs for search and initiation, negotiation, and control of an inter company business relation explain additional efforts to a certain extent [3]. Nevertheless, companies do not have sufficient knowledge about their transaction costs especially when sourcing from offshore suppliers. A study in Germany recently discovered that 63% of 203 German companies that source from China do not use performance measures to control their logistics [4].

The analysis of purchasing costs is related to the concept of total cost of ownership (TCO), a buzz word that was born in the IT industry in the 90s. The concept analyses the total operation costs of software and hardware. Nowadays, the concept of TCO is commonly known in purchasing departments as well but seldom applied in an integral way

[5]. The objective of TCO is to understand the true costs of goods and not just the pure purchase price [6]. The core idea behind the accounting concept of TCO is to allocate all costs, additional efforts and opportunity costs of a purchase to the price per unit. For example, the initiation of business with a new supplier, higher efforts in the own company due to larger coordination necessities with offshore suppliers, and – especially when talking about sourcing from low labour cost countries – intensified quality inspection on arrival of purchased goods are normally not considered when calculating the costs of a product.

TCO has been recently discussed in scientific journals as well as rather populist magazines. In scientific literature, the common incentive in the model constructing publications is understanding the firm's true cost, not just price, for a given purchase [7]. Ex-post supplier performance measurement is the motivation stated most often for applying TCO. Related tasks are the strategic make-or-buy decision [8], supplier selection [9] and ex-ante supplier evaluation [10]. The common benefit of the cited scholars is transparency by detailed knowledge of all costs involved in purchasing goods. Cost information might also be used to enhance price negotiations with suppliers [10], to incorporate non-price considerations into the make-or-buy decision [8], and to control the assessment of sourcing risks [11]. Some scholars considered barriers and difficulties when implementing TCO in enterprises [6, 9, 12]. The lack of data sources is the biggest challenge for implementing an integral TCO model. Furthermore, in smaller enterprises cost transparency is often not appreciated because employees do not like their performance to be measured and do not want their efforts be allocated to certain jobs.

The biggest achievement of the publications focussing on model building is developing awareness of additional costs to be incorporated on top of the purchase price by listing cost objectives that should be considered (see [5] for the most complete overview of TCO cost objects). Three different methods of structuring cost objects are discussed. First, most of the authors suggest a structure that is aligned with the functional departments of a company including product-related categories like management, delivery, service, communication, price and quality [6]. Second, objects can be categorized according to the phases of the product life cycle like acquisition, reception, possession, utilization, and elimination [10]. Third, purchase hierarchies can be utilized considering costs objects related to unit, batch, order, or supplier [13].

The most detailed case study of TCO is presented by [14]. The TCO model for a vehicle glass repair and replacement expert operating in the after-sales market consists of 8 aggregated cost categories. Each cost category is quantified by a formula containing simple key performance indicators as variables. The target of the presented TCO model is making volume-allocation decisions in the service industry.

There are two shortcomings in the presented literature. First, the integration of opportunity costs has not been considered thoroughly. Second, the concept of TCO has not been applied to global sourcing yet. What are the opportunity costs of switching to a supplier in a low labour cost country with average lead time of 6 weeks instead of one week from a local supplier? What are the opportunity costs of low quality due to personnel fluctuation at the supplier's? These questions show that low cost is not the only entrepreneurial objective. There are other objectives like quality, delivery and flexibility [15] that have to be considered as well in terms of opportunity costs.

2. Objectives

The objectives of this paper are threefold. First, it presents a method for categorizing various cost objects of an integral TCO analysis. The second objective is an approach for identifying cost objects to be applied in practice. Last, the paper shows the analysis of opportunity costs concerning entrepreneurial objectives that are not related to costs as there

are quality, delivery and flexibility. The paper proposes a method for transferring supply chain metrics into surcharges to be added on top of the unit price of purchased goods.

The focus of this research is the evaluation of procurement activities of Swiss companies sourcing offshore from external suppliers in Asia. The considered products are mechanical and electrical components that are finally assembled and sold in Europe. The integration of monetary costs, transaction costs and opportunity costs into a holistic total cost of ownership calculation facilitates a transparent evaluation and comparison of several sourcing options.

3. Methodology

The presented research is embedded in the framework of action research consisting of four main stages: problem definition, state-of-the-art of science, conception and validation [16]. The close interaction of researchers and industry partners ensures the formulation of target-oriented approaches that are applied in industry. Up to eight industry partners were involved in the phases of problem definition, conception and validation.

4. Model Description

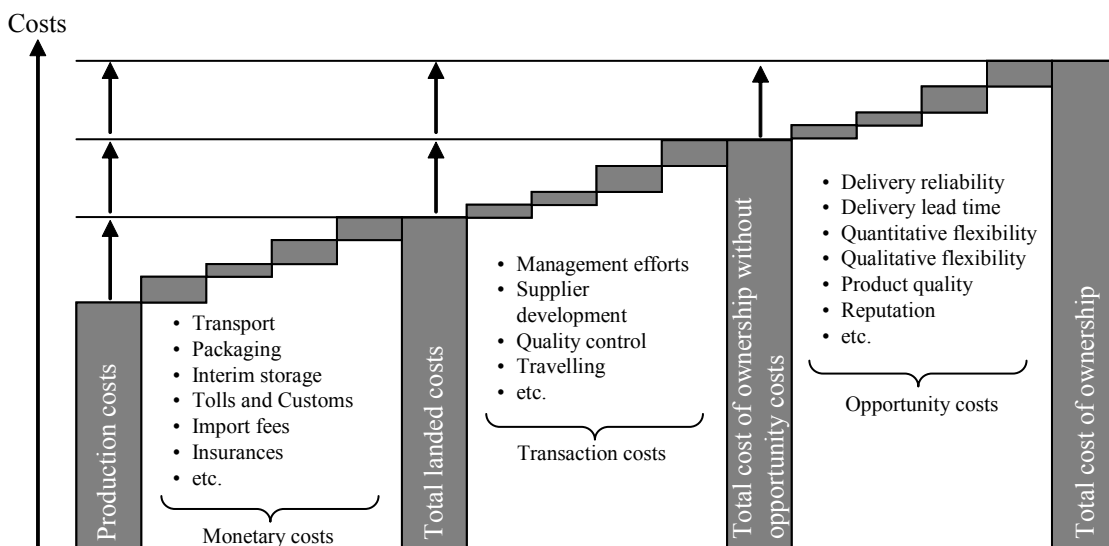### 4.1 Categorization of Cost Objects

Figure 1: Categorization of TCO Cost Objects

In industry, the use of landed costs for analyzing procured goods is very common as interviews with Swiss companies have shown. Landed costs usually cover the manufacturing costs and monetary costs related to transport logistics like packaging, transport, interim storage, tolls, custom clearance, import fees and insurances (total landed costs). Furthermore, transaction costs related to additional company-internal efforts for globally sourced goods have to be identified and quantified. Travelling costs, communication problems and higher efforts in managing the supply chain are examples of these. Last, entrepreneurial objectives other than costs like quality, delivery and flexibility are incorporated in the concept by opportunity costs. In order to meet the customer's tolerance time, a delivery lead time of 6 weeks from China compared to much shorter lead times when sourcing locally causes opportunity costs, for example, due to increasing inventory requirements (see Figure 1).

4.2 Identification of Cost Objects

The identification of cost objects related to global sourcing projects is a complex problem involving many stakeholders and scarcity of data. The target of the presented method is identifying and quantifying costs of the categories cash flow, working effort and capital employed that exceed the analysis of landed costs, and assigning them to the price per unit of procured goods. Five steps are proposed:

1. Kick-off workshop,
2. Allocation of cost objects,
3. Prioritization,
4. Data collection and
5. Quantification.

The workshop is held with representatives from several departments like procurement, supply chain management, research and development, product management and controlling. After the definition and delimitation of the addressed problem, the team agrees on an exemplary case of an existing supply chain. The method of brainstorming is used to collect a first set of cost objects. In a second step, a reference process model for sourcing is employed to find more detailed objects. The sourcing processes cover strategic and operational elements which are necessary to accomplish global sourcing projects successfully. The process chain starts with the design of the production and procurement strategy. Procurement market research and supplier selection complete the strategic process elements. On the operational side there is design adaptation, production ramp-up, supplier development, operational sourcing, transport logistics, and after sales services. Using this method of categorizing cost objects, a purchasing manager can easily identify the origin of lavish processes. At last, a standard list of potential cost objects is presented (compare [5]) and synchronized with the existent collection.

The collected cost objects are allocated to the stakeholder they belong to. In bilateral sessions with the researcher these owners decide on the relevance and priority of a cost object. Furthermore, the method of quantification is selected as there are simple proportional calculation, activity based costing and the net present value method. The necessary data is defined and collected or estimated if precise figures are not available. Finally, the quantified cost objects are consolidated in a database and allocated to the price per unit of the selected good resulting in the total cost of ownership.

In a case study with three companies the described approach was carried out (see Table 1). The matrix contains the TCO cost objects allocated to the cost categories on the x-axis and to the sourcing processes on the y-axis.

		Cost categories		
		Monetary costs	Transaction costs	Opportunity costs
Sourcing processes	Production and procurement strategy	▪ Layoffs ▪ Local Sourcing Office ▪ Sourcing Agent / Freelancer	▪ Strategic planning of supply chain ▪ Implementation of multiple sourcing strategy ▪ Integration into production network ▪ Compliance of ROHS and WEEE	▪ Higher safety stock due to deficient delivery reliability, quality fluctuation and longer lead times ▪ Inappropriate payment terms ▪ All-time buys ▪ Capital employed for goods in transit ▪ Fix costs for idle inhouse production factors ▪ Reputation loss due to foreign content
	Procurement market research	▪ Purchase of studies	▪ Search for potential suppliers ▪ Study of literature	
	Supplier selection	▪ Contracting and legal fees	▪ Supplier audits ▪ Adaptation of documents to new language and norms ▪ Analyses of cost structure of supplier	
	Design adaptation	▪ PDM/PLM System	▪ Split of order because of IPR-protection ▪ Iterative design adaptation	
	Production ramp-up	▪ Prototypes with new supplier ▪ External quality control ▪ Materials, tools, and machines ▪ Testing equipment and tools	▪ Production trial / sample runs ▪ Preparation of work & test instructions ▪ Development of testing tools	
	Supplier development	▪ Production costs	▪ Continuous development and coaching of supplier ▪ Supplier performance measurement ▪ Supply management of raw material	
	Operational sourcing	▪ External quality control ▪ Safety stock	▪ Language and time difference ▪ Planning and forecasting ▪ Internal quality control ▪ Ordering and monitoring of delivery date ▪ Negotiation of terms	
	Transport logistics	▪ Customs and taxes ▪ Transport ▪ Quota costs ▪ Interim inventory holding ▪ Insurances	▪ Know-how about international import and export	
	After sales services	(n.a.)	▪ Analyses of returns	

Table 1: TCO Cost Objects from a Case Study with Three Companies

4.3 Opportunity Costs

In industry, the achievement of low manufacturing costs is not the only entrepreneurial objective. Quality, delivery and flexibility are other objectives mentioned in literature [15]. The SCOR model proposes five objectives of managing a supply chain, three customer-faced performance attributes – reliability, responsiveness, agility – and two internal-faced ones – costs, assets [17]. The performance of a supply chain concerning these objectives can be measured by specific metrics that facilitate the rating of a supply chain. How can those characteristics of a supply chain be related to the costs per unit? What are additional costs when purchasing goods from an offshore supplier with a delivery reliability of 92% and a delivery lead time of four weeks?

A general model assists companies to incorporate opportunity costs into their decision making methods. The company specific set of entrepreneurial objectives is denoted by $O := \{o_a \mid a = 1,2,...,A\}$. Each objective may be affected by a set of quantifiable drivers or supply chain metrics. The company has to establish a supply chain measurement system defining metrics that are maintained continuously as represented by the set $D_a := \{d_{a,b} \mid b = 1,2,...,B\}$. The drivers cause opportunity costs that are denoted in the set $C_{a,b} := \{c_{a,b,e} \mid e = 1,2,...,E\}$.

Each term of opportunity cost elements $c_{a,b,e}$ is a function of the corresponding driver $d_{a,b.}$

$$c_{a,b,e} = f(d_{a,b})$$

The aggregated opportunity costs for each entrepreneurial objective as surcharge per unit is the sum of all driver-affected costs divided by the number of considered units of sourced goods N.

$$c_{aggr,a} = \frac{\sum_{b=1}^{B} \sum_{e=1}^{E} c_{a,b,e}}{N}$$

A simple spreadsheet can visualize the production costs, total landed cost and total cost of ownership without opportunity costs and total cost of ownership including opportunity costs. This enables the supply chain manager to compare sourcing options.

An example of the general calculation model for opportunity costs stresses the impact of longer lead times in case of sea freight resulting in increased requirements of safety stock. The corresponding entrepreneurial objective $o_1 = delivery$, driver $d_{1,1} = lead\ time$, opportunity cost element $c_{1,1,1} = safety\ stock$ and formula f,

$$c_{1,1,1} = f(d_{1,1}) = s_c \cdot s_f \cdot \sqrt{\frac{d_{1,1}}{1a}} \cdot \sigma_{1a},$$

given that s_c is a proportional factor converting safety stocks into monetary units, s_f is the safety factor and σ_{1a} is the standard deviation of the demand during the statistic period of 1 year (compare [15]). A delivery lead time of 6 weeks compared to a delivery lead time of 1 week results in safety stocks that are 2.45 times higher granting the same service level.

5.   Conclusions

The paper presents a model to analyze the total cost of ownership of globally procured goods for manufacturing industries. The integration of monetary costs, transaction costs and opportunity costs into a holistic total cost of ownership model allows a transparent evaluation and comparison of several sourcing options. The model enables decision makers to understand the true costs of a purchase (ex-post) and to draw strategic conclusions for the management of their supply chains (ex-ante).

Supply chain risks have lately been discussed in literature stressing the importance of risk analyses especially in global supply chains [18]. A sudden breakdown of a single source supplier or the loss of a whole shipment can affect a company's supply with significant impact. Results of a supply chain risk analysis are not integrated in the total cost of ownership model.

Further research will be necessary to identify all relevant cost drivers of opportunity costs concerning global sourcing and to derive corresponding formulas that convert cost drivers into opportunity costs.

Acknowledgement

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