

Supplier Selection Model Based on Total Cost of Ownership

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Abstract This paper proposes a model to offer, from a strategic viewpoint, the application of selection of suppliers based on the Total Cost of Ownership (TCO), aimed at a group of energy generation (Global Participações em Energia), whose equipment directed at the study make up the Organic Rankine Cycle. The methodology integrates the incorporation of all costs involved, in order to identify the necessary steps for analysis of the selection of suppliers. So, it explores an innovative approach, which provides support for investment decisions and management of the organization. Consequently, it allows guiding the options of industrial arrangements, making it possible to implement diagnostic solutions for a set of assets, maintaining a systemic perspective and conducted through the life cycle of the equipment. After that, this paper understood that the correct selection of suppliers, according to the aspects of strategic purchasing and Supply Chain Management, might affect the primary objectives of reducing costs, risk mitigation and receiving better services.

Keywords: Total Cost of Ownership, Supplier selection, Strategic purchasing.

1 Introduction

Controlling all costs and managing acquisition expenses have become pivotal goals for companies recently. Thus, the total cost of ownership (TCO), makes the buyers can go beyond bottom-line cost. In practical terms, the buyer will inevitable be posed with the following question: What are the theoretical underpinnings of Total Cost of Ownership analysis for development of a supplier selection model? Therefore, this work explores the definition of a supplier selection model based on total cost of ownership that follow an innovative methodology that provides support for investment and management decisions. By the way, it is fundamental to explain the benefits sought in TCO implementation; the potential uses of TCO models, and the steps of TCO model development and adjustment.

TCO can bring out hidden costs of ownership. Management chooses to include all-important costs caused by the system acquisition, including the labor costs of people who do the usage of the system. Therefore, using Total Cost of Ownership (TCO) is an assessment of all costs, direct and indirect, involved with an item over the useful life of that item. Most frequently, TCO is used at the beginning of the purchase process to evaluate which is the most cost-effective choice. TCO is also applied to determine overall lifecycle cost of a product or service; to compare and contrast different variables associated with a purchase; to integrate sustainability into the procurement process; to assess the ongoing costs of a specific purchase; and, mainly to structure a supplier selection.

This research involved a study to advance knowledge and extend previously developed theories about two phenomena, management accounting and supplier selection, by linking these different topics under a common general statement about Total Cost of Ownership. Through a formalized model is defined as a written, documented method for determining the total costs associated with the acquisition and subsequent use and disposition of a given item/service from a given supplier. Thus, because of the limited amount of data available on TCO models in the literature, this research is exploratory in nature. It seeks to describe

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and understand TCO analysis in depth, rather than provide a broad but limited picture of TCO practices.

2 Total Cost of Ownership

The global economic system has been one of the most important factor to developing of the century. This process has materialized in a remarkable growth of world trade and consequently, has produced a phenomenon that changed the foundations of many internal activities [1]. As a result, the concept of supply chain emerged and facilitated the process of integration between the scattered company entities throughout the world, as well as the integration between independent companies that operate within one supply chain [1]. Thereby, total cost management appears as way of the companies might make its activities faster, according a structured plan, controlling and executing a product's flow from materials to production to distribution in the most economical way possible [1,2]. Shown in Fig.1 introduce as goods are distributed via wholesalers or distribution centers while the latter can be managed by the brand owner itself or by a third party logistic provider. The latter becomes more and more important especially in smaller regions or when special requirements.

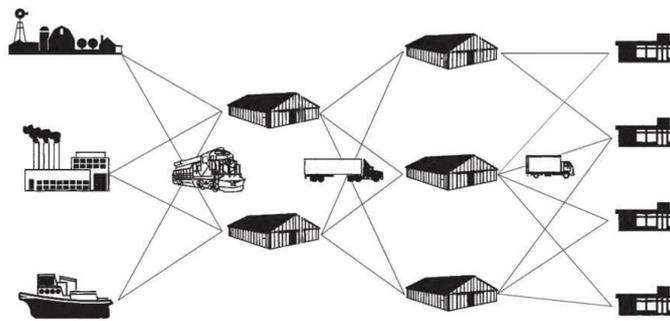


Fig. 1. Supply Chain

Companies must weigh the benefits and disadvantages of different options presented by international supply chains for the acquisition of goods and services at the best possible price, in the right quantity and at the right time. In face of, to control is associated with regulating and managing all costs as well as checking and testing. In contrast, the innovation is connected with the activity of managing and regulating in which controlling has become a specific concept of business management based on organizational connection of planning and control processes [3]. As result, Total Cost of Ownership is intended to help buyers and owners to determine the purchase price of an asset plus the costs of operation. It takes a bigger picture at what the product is and at what its value is over time. TCO adopts a process-oriented planning and control of the flow of goods, information, and money across the entire value and supply chain from the customer to the raw material supplier [4].

Total Cost of Ownership (TCO) is an assessment of all costs, direct (business expenses that can be directly applied to producing a specific cost object, like a good or service) and indirect (used by multiple activities, and which cannot therefore be assigned to specific cost objects), involved with an item over the useful life of that item. In other words, it is an estimate of the total costs of goods, services or construction works over the whole of their life [5]. This way, TCO is a purchasing tool and philosophy, which aims to understand the true cost of buying a particular good or service from a particular supplier. Its concept takes into account all costs that the purchase and the subsequent use of components entail in the entire value chain of the company, and thus expands the notion of purchasing cost by combining the life cycle cost effects with the acquisition price [5, 6].

As a result, comparisons of suppliers and their respective offerings are based on evaluation of all relevant performance characteristics on a monetary basis. However, part of good procurement is achieving the right price [6]. Best value for money is the lowest whole-of-life cost. This involves identifying the initial purchase price and estimating all future costs and returns [7]. Although, this oriented purchasing approach,

TCO is most often used for the supplier selection decision. Nevertheless, it could also be used to evaluate a supplier's performance in an attempt to enhance the value delivered to the buying organization [5-7].

In its turn, it should consider the TCO if you expect to be able to make a smarter purchase by looking at the total life cycle costs of a product or service. In face this; the actual scope of TCO may differ across products [7]. Activities related to purchasing can be divided into pre-transaction; transaction (transportation costs, sample reviews, invoicing, inspections, total landed costs for international purchases, rejected product handling, and follow-up and improvements for future orders); and post-transaction elements (line fall-out; defective rejects before shipping; repair and replacement; materials disposal; obsolescence; and the cost of holding inventory) [8].

TCO analysis provides a methodology for quantifying make or purchase decisions in the best possible manner [8]. If applied properly companies get a complete picture of costs associated with the investment, when assessing different business models, maintenance options or solutions on a comparable cost basis, in selecting the best supplier by assessing the comparative whole-of-life costs of competing bids and to track actual expenses and income against budget [9]. For this reason, to develop an understanding of total costs, approaches can be used face monetary-based method, which allocates the costs of purchasing an offering (goods or service) to the different cost components based on costs [10]. By contrast, another method is the cost-ratio or value-based method, that combines with quantitative and qualitative performance information together. At last, a third method proposes a mathematical programming decision model that can be formulated for supplier selection and order quantity determination [9, 10].

2.1 Total Cost of Ownership Structure

The first step in performing any TCO analysis is to describe the lifecycle of the product or service, because normally that the greater the responsibility take yourself for the costs during the total life cycle, more important a TCO analysis is [11]. In other words, It is defined as the cost analysis tool that incorporates the purchase price of equipment and all operating and related costs over the life of the item including downtime, maintenance, energy costs and salvage costs (It is usually applied to capital acquisitions) [11,12]. Consequently, the lifecycle of most materials will contain analytical processes by which managers can make the most cost-effective decisions on options presented to them at differing stages and at different levels of the cost estimate. After that, the main cost categories that can be included in a life cycle costing calculation are those related to: Research, development and design; Primary production; Manufacturing; Use; Disposal [12].

Lifecycle costing focuses primarily on capital or fixed assets, in the same way that, understands the purchase price and on determining how much it actually costs to organization to use, maintain, and dispose of that asset during its lifetime. The life-

cycle approach is congruent with TCO, but represents only a subset it, because, the scope include the pre-purchase costs associated with a particular supplier [12, 13]. Therefore, procurement managers must consider the following cost elements for the calculation of the life cycle costs of a particular procurement item:

- purchase price or lease costs;
- Transportation costs (if not already included in the cost of purchase);
 - Installation costs (means all costs actually incurred performance of the work as installation costs may only include expenses, fees, tax and charges incurred) [13].

This way, TCO analysis supports a whole spectrum of decisions from routine day- to-day operating decisions, such as how much production order should be allocated to the customers, to strategic decisions such as how to reengineer a process [13]. In the same way that, an organization needs to come up with the list of costs, estimate the values of those costs and identify which of those costs are critical to determine the total cost of ownership. So, before laying out the framework need to discuss the type of cost elements in each of the TCO categories [14].

Table 1. Types of costs

Type of Cost	Description
Sunk	Sunk costs are costs that have already been incurred in the past and which cannot be recovered if the project is called off, for instance early market research and document preparation.
Overhead	Overhead costs often referred to as overhead or operating expenses, refer to those expenses associated with running a business that cannot be linked to creating or producing a product or service. They are the expenses the business incurs to stay in business, regardless of its success level.
Purchasing	Purchasing costs is the cost of buying inventory during a period for the purpose of sale in the ordinary course of the business. It is therefore a kind of expense included in the income statement within the cost of goods sold (e.g. closing, research, accounting, commissions, and legal fees).
Operating	Operating costs are associated with the maintenance and administration of a business on a day-to-day basis. It includes direct costs from operating expenses (which exclude direct production costs), and so includes everything from rent, payroll, and other overhead costs to raw materials and maintenance expenses, likewise installation, training, maintenance and efficient.
End of life	Costs incurred in the termination of products life (disposal costs, excess inventory, winding down of project costs), likewise destroy/recycle, resell, refurbish, and redeploy, dismantling cost, additional disposal costs.

In order to implement the TCO for any purchase, it is required to have framework that guides company to consider important steps in the process of TCO implementation [15]. Regarding this, Total Cost of Ownership structure can fallows from:

- Step 1: Identify Needs (the first step is to identify define objectives and scope, identify needs, form a cross functional TCO Team, identify relevant costs, categories them, focus on test and implement by studying all costs);
- Step 2: Define Objectives and Scope (to determine the objective to be achieved by meeting the needs obtained in Step 1: In addition to, the objectives chosen will form the basis of the criteria and clauses in your approach of purchase);
- Step 3: Form a cross functional TCO Team (to form a Team approach in development of TCO modeling over procurement department working with other functional areas);
- Step 4: Identify and Categorize Relevant Costs and Focus on Critical Costs (to identify the cost expected cost of performing work to each activity. Cost estimates can include labor, materials, equipment, and any other direct costs for project activities);
- Step 5: Test and Implement by Studying all Costs Heads and Fine Tune if Required (to test the model and verify the results as per the requirement);
- Step 6: Develop Recommendations and Make the Decision (the results of the analysis should reveal advantages and disadvantages of each option, pointing to one leading option over others).

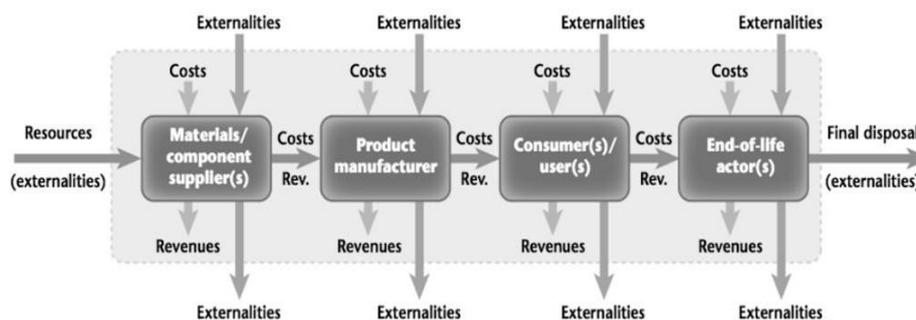


Fig. 2. Flow of production costs

Initially, the TCO was only an economic tool, with the aim of analyzing past, present and future costs in order to choose the most cost-effective option [16]. Then, as an assessment of all costs associated with the life cycle of a product that are directly covered by any one or more of the actors in the product life cycle (supplier, producer, user/consumer), with complimentary inclusion of externalities (external costs as the costs that are envisioned to include the monetized effects of environmental and social impacts not directly billed to the firm, consumer, or government etc.) that is producing, using, or handling the product) that are anticipated to be internalized in the decision-relevant future [16].

3 Task Environment

The Global Group began more than twenty years ago by providing industrial maintenance and construction services. However, its growth in the recent years has been mostly in the power industry, and the Group is proud to be one of those responsible for developing the sector in the country. The Group won its first national power auction and, from then on, several factors contributed to its exponential growth. The Global Group is present today in the states of Amazonas, Rio Grande do Norte and Bahia, where its main office is located, in the city of Salvador. Their focus its efforts on obtaining knowledge, products and solutions that add value to the plants it controls and operates, to Brazilian Electrical Sector and to society, as a result of the training provided by the themes and subjects addressed, both in the area of plant operation and in the development of studies of renewable generation sources [17].

This way, Global Group intend to works through Organic Rankine Cycle (ORC), for the combined generation of electric power and heat, employing renewable resources and heat recovery from industrial processes, engines and gas turbines, particularly well-suited for distributed generation. In other words, ORC technology is similar to a traditional steam turbine. However, instead of using water vapor, the ORC system vaporizes a high-molecular-mass organic fluid, resulting in excellent electric performance and several key advantages: slower turbine rotation, lower pressure and no erosion of metallic parts and blades [18].

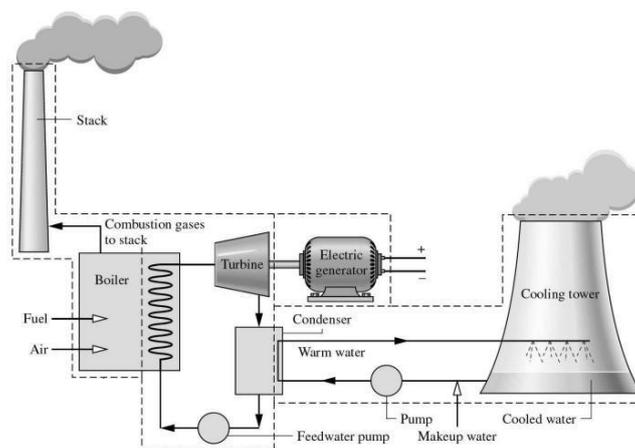


Fig. 3. Power Plant System

This process widely used by power plants such as coal-fired power plants or nuclear reactors. In this mechanism, a fuel is used to produce heat within a boiler, converting water into steam that then expands through a turbine producing useful work. Then, the corresponding equipment to selection process are outlined from on a heat exchanger (a heat transfer device that exchanges heat between two or more process fluids), that in this case might be U Tube bundle Heat Exchanger or plate heat exchanger [19]. A pump is a necessary component of ORC units. Although it is simple in a principle and various pump types can be used, reality may easily bring many complications. Numerous factors affect the pumping work value. The most important ones are ORC power plant working temperature range; Working fluid properties; Power plant arrangement; Pump efficiency [20]. Finally, in the steam turbine, the steam is expanded to a lower pressure providing shaft power to drive a generator or run a mechanical process. There are two

distinct designs for steam turbines – impulse and reaction turbines [21].

The estimation of the costs of equipment is a task that involves capital costs, or capital investment, refer to the one-time costs (beginning of the project). These total investment costs include the costs directly associated with the system (equipment, materials, labor etc. required for the equipment and the installation thereof), indirect costs (engineering, construction costs, and contingencies), and other outlays (such as startup costs, working capital etc.). Next table provides a better view on the estimated costs.

Table 2. Estimation of the costs of equipment

Type of Cost	Description
Sunk	Early market research and document preparation.
Overhead	Product (unit price, taxes, customs costs).
Purchasing	Employee salaries, cleaning, and conservation.
Operating	Installation, maintenance, efficiency, training, depreciation.
End of life	Disposal, disassembly cost, additional disposal costs.

Finally, it is important to take the difference between all costs involved in this type of study. Costs reflect the amount that is required to obtain equipment, so the price is the amount you pay to purchase it. The costs associated with producing an ORC system will this differ from the price paid to acquire that system. This way, many correlations are used to estimate costs that will be obtained using supplier prices to ORC development or possibility purchase this equipment.

3.1 Strategic Structure for Modeling of Supplier Selection

When buying a power plant equipment, the price reflects one small part of a whole. So, the amount on the price tag represents less than the total cost spent on a piece of equipment over its lifetime. As result, it is necessary to consider these factors as part of the price during their selection process. TCO must be used for full evaluation, which is an estimate of all collective expenses associated with the purchasing and operating a piece of the equipment. The complete iterative procedure is described in this section, step by step.

- Step 1 – Context: The first step of the methodology consists in the clear identification of the context in which the equipment will be introduced, defining the asset system (production plant) to be analyzed and modeled. In this step it is important to clearly identify the production capacity, budget, quality of products, performance indicators, layout configuration.
- Step 2 – Determine the form of contract: Compare various forms of contract. It should be according set out agreed terms in performance contracts. Must have record the performances promised by suppliers in the document.
- Step 3 – Select criteria about Flow Progressive Logistics: Within current modal logistics directives the costs factors can be translated into vehicles, drivers, warehousecriteria in the request. Then the calculation of these must be comprehensible.
- Step 4 – Data collection: This step is dedicated to will be considered technical and economic data. Regarding the needed technical data to perform the performance analysis for each component of the system, should be identified the time between failures and time to repair (must be considered that cycle life these equipment are twenty years approximately). Regarding the economic data, they are the ones needed to quantify the cost items in the cost breakdown structure and to estimate the TCO of the asset.
- Step 5 – TCO calculation: This step allows to evaluate each items cost (direct or indirect) and cost flows, quantifying the net present value. To calculation is necessary to add the initial cost, maintenance, downtime, production, and disposal.

In order that explain with detail, the key point is the definition of practical methodology to implement supplier selection activities through a significant integration between technical performance evaluation and economic assessment by TCO evaluation. The introduction of a step for the generation of the alternative

scenarios for evaluating the criteria of different types of valuation systems and quality of diagnostic capabilities, through data collection and TCO estimation, finally make this validation of proposed methodology within Global Group. Overall, the defined methodology represents a good decision-making support to identify all costs. In fact, it allows managing a better utilization of resources because it avoids financial loss.

4 Conclusion

The role of supplier selection process and evaluation has become more than ever imperative for supply chain performance. Due to, supplier selection process and evaluation represents one of the key activities that organizations must integrate into their core strategic decisions. Therefore, this is an important supplier selection approach because it supports decision makers in ranking potential suppliers based on the relative significance of the measured costs. Through this paper, it is understood that selecting and evaluating the right suppliers is the aspect of strategic purchasing and supply chain management that can affect the primary objectives of reduce costs, mitigate risks, and receive better services.

About limitations of the study, observed that this research has not used simulated quantitative data for some predefined input variables in the steps. So, it cannot be used to select optimal supplier based on optimized order quantity allocation. Thus, the model assumes that suppliers are able to move in this direction in order to achieve complete efficiency. On the other hand, as suggestions for further studies and researches is needed using costs effective measures, in doing so, the possible scenarios to supplier selection can also include the integration of other management accounting techniques.

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