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A cost analysis model for heavy equipment

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ABSTRACT

Total cost is one of the most important factors for a heavy equipment product purchase decision. However, the different cost views and perspectives of performance expectations between the different involved stakeholders may cause customer relation problems between the manufacturers and customers. Beginning with the conventional manufacturers' cost view, this paper presents the necessity and importance of expanding the heavy equipment manufacturers' cost scope to include the post-manufacturing customer stage of their products. Then, this paper narrates a general mathematics Post-Manufacturing Product Cost (PMPC) model to analyze the total costs of heavy equipment in its utilization stage. A major emphasis of the PMPC model is placed on the strategy of improving the manufacturers product cost management and the strategy of customers purchasing decisions cost management and their interdependencies as related to their specific different perspectives on the product utilization patterns.

1. Introduction

In the last century, new product development in the manufacturing environment has changed significantly to meet the challenge of global competition. To survive internationally, manufacturing firms must strategically examine customer needs and values in all their served market segments. Increasing complexity and costs of new products place an increased importance on a system life-cycle cost analysis by the vendors and customers. Furthermore, this life-cycle cost view is of particular importance for revenue generator products. For instance, Hitachi Construction Truck Manufacturing, Ltd. is a multi-international manufacturer for off-highway, rigid dump trucks. Its products consist of 30 to over 300 ton rigid haulers with typical life spans of approximately 10 years. The initial cost of rigid haulers can be over one million dollars and corresponding operating costs approximately three to four times of the initial cost. Under these circumstances, a proper cost-evaluating model becomes extremely important.

The traditional cost analysis models can be classified into three categories: manufacturer-oriented cost analysis models, end-user-oriented cost analysis models, and life-cycle cost models.

The typical manufacturer-oriented cost analysis models include productive hour rate costing, process costing, activity-based costing, and precision engineered costing system. Ostwald's Productive Hour Rate Costing Model calculates the productive hourly rate by adding the machine hourly rate and the direct labor hourly rate (Sims, 1995). Woods's Process Costing Model assigns costs to process by accounting for the degree to which the processes cause costs to be incurred (Clark & Lorenzoni, 1978). Activity-Based Costing (ABC) solves the cost accounting precision problem by assigning "cost drivers" to the various sources or elements of manufacturing expense. Sims's Precision Engineered Costing System is a cost method for both piece part and continuous process manufacturing operations. Sims's System focuses on the cost-finding impact of capital intensive and high tech operations.

Manufacturer-oriented cost analysis models are deployed by manufacturers to analyze product manufacturing and warranty cost. The major problem with those models is that they can only be applied to manufacturing cost analysis. In other words, they are not total cost analysis models. Therefore, those models can not provide the total cost data to meet customer needs.

The typical end-user-oriented cost analysis models include Benefit-Cost Analysis (BCA) and Total Cost Analysis (TCA). Benefit-cost analysis, which is also known as Cost-benefit analysis, was first demonstrated by Benjamin Franklin in one of his letters from the 1770s. Since its conception, Cost-benefit analysis has been widely deployed in the fields of health and community services, defense and R&D, natural resources, transport, and investment problems (Berliner, Brimson, & James, 1988; Gramlich, 1981). BCA includes two topics: the formulation of alternatives; and the enumeration, quantification, and (when possible) valuation of the relevant costs and benefits of each decision algorithm and preference function (Turvey, 1971). The Total Cost Analysis (TCA) approach suggested by DeCorla-Souza, Everett, Gardner, and Culp (1997) is an alternative to Benefit-Cost Analysis (BCA) for evaluating transportation alternatives. In the TCA approach, benefits involving "cost savings"

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are automatically considered on the "cost" side of the equation and not the "benefits" side. In BCA, most or all monetized benefits are really cost savings.

The main problem with end-user-oriented models is that the product most likely will play a static role in the analysis process. End-user-oriented models, which are deployed by end-users and not manufacturers, attempt to make general criteria for computing operating cost. Regardless of the performance variation among the same type of products from different manufacturers, end-user-oriented models only consider the variation of the product's quantity and functionality. Once the quantity and functionality are determined, the operating cost of the equipment is determined. The best interest of those models is to pick an optimal solution from a group of candidates on the method/path level. In other words, they do not really analyze the cost of different entities performing the same task. For instance, the TCA model for transportation cost analysis classifies the transportation tools into three different categories: private vehicle, public bus, and rail. Upon selecting the "private vehicle" category, the TCA model will not help in picking a kind of "private vehicle". The result of those models helps people make high level decisions, but it does not helps manufacturers or customers when promoting the product or making the purchase decision.

Fig. 1 presents a typical product/system life-cycle economic model from the manufacturer perspective as described by Chen and Keys (2003). It demonstrates the costs incurred to the manufacturer from marketing's conceptual development through prototype design, development into production, and field costs. Keys (1991) identifies field costs as including manufacturer covered post-manufacturing cost items, such as warrantee optimization, associated dealer/customer allowances, and customer service. More details on these costing can also be found in Keys (1990), Locascio (2000), Sheldon, Huang, and Perks (1991), Keys, Balmer, and Creswell (1987), and Menezes (1990).

In general, the utilization costs of heavy equipment contain two parts: ownership costs and operating costs. The operating costs are normally much bigger than the ownership costs. There is now a clear understanding between manufacturers and customers. One of the fundamental cost problems so-called "lack of total cost visibility" as reported by Blanchard (2003) in Fig. 2 has been well recognized after introducing the principle of the system life-cycle cost. However, when investigating those visible and invisible costs in detail, manufacturers and customers start to show their significantly different interests, perspectives and concerns. These differences are the issues of the typical life-cycle cost model.

First, different concerns will be presented regarding costs. While all costs are integrated, the typical system life-cycle cost view does not clearly distinguish the different cost "partner" responsibilities, (i.e., the different detailed cost concerns). Traditionally, a major concern of manufacturers is all about the Product Manufacturing Cost (PMC). On the other hand, customers could care less about the PMC. Their focus is on the costs to own/lease the machine and keep it running (i.e., the total product utilization cost or the Post-Manufacturing Product Cost (PMPC) as reported by Chen (2002)). Fig. 3 depicts PMC and PMPC cost curves based on the system life-cycle cost view. Neither of these two cost concerns are completed because PMC and PMPC are interrelated. In order to create a long-term relationship with its customers, a heavy equipment manufacturer has to realize the trade-off between PMC and PMPC. Hence, the cost interests of a manufacturer should include both PMC and PMPC. Manufacturers can reduce PMC by using less expensive components or materials without considering the possibility of increasing the PMPC on the customer side.

Second, differences in cost definitions will be presented. In a mining job site, cost data is collected on a regular basis so that the mine managers have a clear idea about the overall costs on the fleet. However, problems and disagreements will come out regarding how to properly allocate and analyze those costs. The collected cost data presents what is really happening in the field. However, this does not necessarily indicate the optical performance for the machine. Furthermore, not all machine costs are ultimately related to a manufacturers' responsibilities. For example, manufacturers are not responsible for the costs of delay in repairs due to lack of required parts. Therefore, it is in the manufacturers' best interests to separate the true machine cost factors away from the noise cost factors. In other words, manufacturers need to generate their cost models to identify the truly best economical performance of their machine by implementing a better understanding and a better technical knowledge of their products. While the ownership costs are more explicit in general, operating costs generally can be much more confusing and cause disagreements between manufacturers and customers.

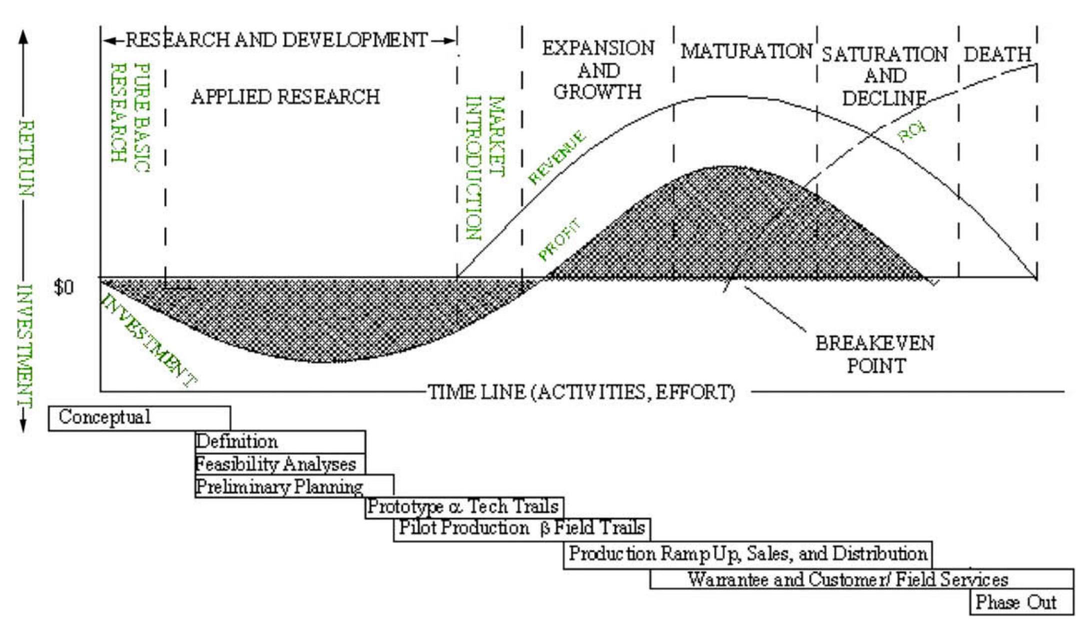

Fig. 1. System production/technology economic life cycles.