Keeping the Competitive Edge

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Applying the total cost assessment (TCA) methodology, which accounts for intangibles, to internal decision-making processes provides a more complete evaluation of costs and benefits with the risks associated with them. It aids managers in making informed decisions about environmental, health, safety and even societal opportunities and impacts.

Many of the decisions companies are making today have financial implications that cannot be accounted for in traditional return on investment calculations. Rising fuel costs, changing marketplaces, and the uncertain effects of climate change are just a few factors that may change the results of a decision — positively or negatively. Some companies have found that capturing these uncertain costs and benefits helps them justify good decisions that don't have traditional payback. While there are a number of alternative accounting techniques available, total cost assessment (TCA) has several advantages. The methodology, developed by industry for industry under a program sponsored by the American Institute of Chemical Engineers, is well developed and documented. Several tools support the analysis, from simple spreadsheets to full Monte Carlo uncertainty analyses. And most important to some users, the methodology allows a company to own the process, the analysis and the results.

The Dow Chemical Co. has made extensive use of the methodology, assessing both its 2005 and 2015 sustainability goals. Dow estimates for the 2005 resource and productivity goal alone, they spent $1 billion, but achieved a value of over $5 billion. TCA has also been used in decision-making at Caterpillar *(1)*, the Port of Houston *(1)*, the government of British Columbia *(2)*, and others.

Costs and benefits

The original scope of the methodology encompassed uncertain environmental, health and safety costs. The method is flexible enough, however, to easily include the benefits associated with a decision, along with nearly any type of uncertain costs or benefits.

Table. Environmental, health and safety cost types in TCA model

Cost Benefit Type	Description
I: Direct	Revenues, capital costs, labor, materials, waste disposal. May have uncertainty attached.
II: Indirect	Non-allocated corporate and plant costs (e.g. reporting costs, regulatory costs, monitoring costs)
III: Future and Contingent Liability	Potential fines, penalties and future liabilities (e.g. non-compliance, remediation, personal injury, property damage, industrial accident costs, changes in regulations)
IV: Intangible - Internal	Difficult to measure costs and benefits borne by the company (e.g. changes in the value of brand value, worker morale, union relations, community relations)
V: Intangible - External	Costs borne by society (e.g. effect of operations on housing costs, degradation of habitat)

Traditional accounting methods used for decision-making typically focus on expected revenues and direct costs (capital, labor, materials and waste disposal), as well as indirect costs (reporting costs, regulatory costs and monitoring costs). The TCA model goes further by defining three additional cost benefit types (Table). Type I, Direct, and Type II, Indirect, start with the same values used in the traditional return on investment model. Users may choose to apply uncertainties to these values as appropriate. Contingent and intangible (Type III, IV and V) costs are more difficult to measure, so the task force developed methods to estimate their effects.

Figure 1. TCA allows uncertainties, such as the probability and cost of a spill to be included in a financial assessment.

Type III, Future and Contingent liabilities, are costs that, should an event occur in the future, will become real Type II costs. These costs capture the possibility that a supplier or employee may make a costly mistake requiring real clean-up and fines, or that environmental legislation may change, assigning costly deadlines on a process change (Figure 1).

Type IV, Intangible — Internal costs and benefits are more difficult to identify and quantify. Often, however, it is in this category that companies find the most benefit. Protecting brand value (or improving a tarnished one), improving employee morale, and reducing regulator scrutiny all have real benefits. Because it is nearly impossible to identify those benefits on the bottom line, they are traditionally ignored. TCA allows those benefits to be captured, quantified and used in the decision.

The last cost benefits type, Type V, Intangible — External, are costs that are not borne by the company directly, but are instead borne by society. Often called "externalities," these costs include the results of pollution on human and ecosystem health, loss of wetlands or other habitats, and the effect of employment on human health, for example.

Many companies, including Dow, chose to omit Type V costs from their first assessments. Dow termed this shortened assessment Total Business Cost Assessment in acknowledgement of their omission. In many cases, including at Dow, Type V costs are coming back into consideration, although often without assigned dollar values.

The seven steps of TCA

Unfortunately, just knowing the cost types doesn't enable a company to perform a robust TCA analysis. Identifying risks and assigning probabilities and costs that stand up to scrutiny require more than the skills of one EH&S employee. And that is just where the methodology offers a unique and solid solution. Few of us would put our faith in a weather forecast by a civil engineer (unless weather forecasting was a hobby). Similarly, we would be hesitant to buy stocks based on a tip from an opera singer. Yet, we daily accept predictions by meteorologists and brokers for this very same information. The difference is not in the uncertainty around the event, but in the expertise of the person doing the predicting. The TCA methodology uses this same concept to achieve credible results. By convening experts in all the areas affected by the decision, the methodology sets the stage for experts in each area to assign probabilities and costs that can be relied upon by the company.

TCA methodology consists of six main steps and a final feedback step that provides input into a company's decision-making process. Steps 3–5 require a meeting of a multidisciplinary team consisting of domain experts from across the company to participate in the brainstorming and reality-checking that a TCA analysis entails.

STEP 1. Goal Definition and Scoping. Define the project and purpose of the TCA analysis. During this stage, it is useful to have a web conference with the domain experts to get buy-in and consensus on the goal and scope.

STEP 2. Streamline the Analysis. Determine what factors are important to the decision and what factors require more effort to quantify than the value they bring to the decision. While this is officially Step 2, teams often iterate this step after each of the other steps.

STEP 3. Identify Potential Risks. Define alternatives, each of which can have numerous risk/cost scenarios. Specify the cost drivers (*e.g.*, compliance obligations and remediation costs). This is the first brainstorming activity and starts with a very open free-flow of ideas. Once the risks have been identified, the team can evaluate the relative importance of impact categories and the feasibility of collecting cost data for them.

STEP 4. Conduct Financial Inventory. Assign Type I, II, III, IV, and V costs. Type I and II costs are derived from a company's internal cost accounting system, but are brought out at this time to ensure nothing has been missed. In many TCA sessions, omitted Type I and II costs have made a significant difference in the outcome. Type III to V costs incorporate probability, frequency of occurrence, and timing of occurrence for important cost categories where relevant data are available.

STEP 5. Conduct Impact Assessment. Review the costs to determine which are the most significant, and assess how that information can best be incorporated into the decision-making process. During this process, the data is fed into a tool, such as TCAce (developed for the AIChE to support the methodology) and analyzed. A sensitivity analysis provides information to the team about what costs and benefits are criti-

Figure 2. When the use of used cooking oil is included in the LCA and TCA analyses of biodiesel, impacts are reduced and profits increase.

cal to the decision and may need more refinement or more attention.

STEP 6. Document Results. Document the assumptions and results for each scenario and cost decision, especially for important potential impacts that are not currently feasible to cost.

STEP 7. Feedback to Company's Decision Loop. Evaluate the TCA results as part of the company's main decision-making process. The final feedback step recognizes that the TCA is only one consideration in an overall process that needs to include many types of information. TCA is a decision-making tool, intended for standalone use to evaluate different alternatives. It is not designed to replace an organization's traditional accounting system, but rather to provide cost information for internal managerial decisions. Each company will have its own policies, principles and values that will guide how the TCA model is applied within the company.

TCA methodology is specifically designed for internal managerial decision-making and provides the costing framework for decisions about process development, product mix, waste management, pollution prevention, facility location and layout, outbound logistics and other business-wide issues. Using TCA allows a business to better control overhead costs and to obtain more accurate estimates of the cost of products and services. Information provided by TCA also improves risk assessment and management.

Case Study: A Biodiesel Facility in Vermont *(3)*

People in the state of Vermont have expressed a desire to maintain their agricultural lands while minimizing their environmental impact, and producing additional revenue streams. One way that these goals might be achieved is with local biorefineries producing biofuels and biolubricants to be used as substitutes for or additives to petroleum-based transportation fuels, lubricants and heating oils. Replacing imported petroleum products with locally produced bioproducts is a uniquely broad application of Green Chemistry.

To determine the feasibility of this project and ensure that it met the expressed goals, two sustainability tools were applied: TCA and life cycle assessment (LCA). These analyses were to provide the basis for a yes or no decision for construction and operation of a new biorefinery. In addition to meeting the goals of the community, the analysis needed to show that the biorefinery would meet corporate goals of profitability, sustainability, use of economical raw materials, and safe and environmentally sound processes and practices. The venture would use locally produced seed crops, and virgin or waste cooking oils as the feedstock for the biorefinery.

A streamlined LCA showed that even using 100% virgin oil, the impacts of biodiesel would be less than petroleum-based diesel. Adding the total cost assessment showed that the enterprise would not only meet the goals of the people in Vermont, but would also prove to be profitable. By using a log-normal distribution to represent the uncertainty in biodiesel selling price and a complex calculation to accommodate the uncertainty of waste cooking oil availability, TCA, and in particular the TCAce tool used in the assessment, enabled developers to quantify their potential upside and downside risks.

Three years later, many diesel pumps in the Burlington, VT, area are supplying a mixture of petroleum diesel and biodiesel, due to the widespread availability of biodiesel (Figure 2). The use of TCA enabled an assessment of both corporate economic goals, and indirectly, the community's social goals. CEP

Literature Cited

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