Business of Safety

Economic Analysis

Make the business case for SH&E

By Anthony Veltri and Jim Ramsay

THE STREAMS OF RESEARCH that examine business outcomes and SH&E outcomes should overlap, but they do not. During the past 20 years, the need to make a business case for confronting and managing SH&E issues and practices has grown (Henn, 1993; Cohan & Gess, 1994; Warren & Weitz, 1994; Cobas, Hendrickson, Lave, et al., 1995; Brouwers & Stevels, 1995; Mizuki, Sandborn & Pitts, 1996; Lashbrook, O'Hara, Dance, et al., 1997; Hart, Hunt, Lidgate, et al., 1998; Timmons, 1999; Nagel, 2000; Warburg, 2001; Adams, 2002; Veltri, Pagell, Behm, et al., 2007). To date, however, the economics of those issues and practices is one of the least-understood subjects (Tipnis, 1994; Asche & Aven, 2004) and little has been done to create economic analysis models that systematically link SH&E issues and practices with business outcomes (Epstein & Roy, 2003).

SH&E tends to tie its outcomes to the overall culture of the organization (e.g., managerial commitment to programs and practices) (Zohar, 1980, 2002; Hofman & Stetzer, 1996; Oliver, Cheyne, Tomas, et al., 2002), but not to business outcomes (Behm, Veltri & Kleinsorge, 2004). In this patchwork of research activity, the authors believe that many business questions are left unanswered such as:

- Which products, technologies, processes and services tend to drive SH&E life cycle cost?
- Which SH&E management strategies and technical tactics should be pursued and what level of investment will be required?
- What is the potential business contribution over the long and short term?

As a result, a firm's investment allocation decision makers cannot make fully informed business and operational decisions when it comes to investing money in confronting and managing SH&E issues and practices. The concern for making a business case for SH&E has resonated in the safety community for some time (Jervis & Collins, 2001; Smallman & John, 2001) and the economic value of SH&E practices has been addressed by many researchers (Behm, et al., 2004; Calow, 1998; Jones-Lee, 1989; Fischoff, Lichtenstein, Slovic, et al., 1981).

Despite the importance of enhancing ways to present the economic soundness of SH&E, firms lack SH&E financial modeling tools to guide their decision making and operating action capabilities (Surma & Vondra, 1992). Several noteworthy conclusions can be gleaned from the literature review; these provide the current level of understanding concerning ways to make the business case for SH&E investments (Veltri, Dance & Nave, 2003a, b).

1) Private-sector companies are less effective than they would like to be in presenting the economic soundness of SH&E investments and in using the information to maintain a balance between externally driven SH&E and internally driven competing business performance. Organizations must understand the cost burdens associated with new, existing and upgraded products, technologies and processes, yet such understanding is rare. The information supporting such decision making should come from design and process engineers who are in a strategic position to supply this essential data. However, if design and process engineers are not provided tools that enable them to profile SH&E costs and profitability potential, they cannot contribute effectively to decision making.

2) Critical business decisions are incomplete when SH&E costs and profitability potential are not disclosed throughout the life cycle of products, technologies and processes. Organizations must account for and link the activities that drive SH&E costs to the products, technologies and processes that generate them. A clear understanding of their total economic

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impact enhances decisions about which products to manufacture, which technologies and processes to employ, and which chemicals and materials to use.

3) Conventional accounting practice tends to aggregate SH&E costs in general overhead accounts. This practice fails to account for the full range of SH&E life cycle costs and fails to allocate them to the product, technology or manufacturing process responsible for their generation.

4) Conventional financial analysis techniques tend to bias investment decisions away from SH&E. It is essential to go beyond the 2- to 3-year time frame used by most companies to evaluate the viability of a strategy. A longer time horizon of 5 to 15 years may be needed to capture recurring costs (e.g., waste, chemicals, materials) or any prestated benefits such as reduced liability.

However, the existing managerial viewpoint sees SH&E investments as costs to be controlled primarily because of regulatory constraints. The authors believe that to make a business case, SH&E should be structured as an enabler of operational and business performance. Conventional wisdom indicates that traditional approaches for justifying SH&E investments must yield to a new fashioned and more economic value way of thinking. Making the business case for SH&E means understanding how SH&E management strategy and practices affect operational and economic outcomes (Nave & Veltri, 2004; Veltri, et al., 2003a, b).

Rationale, Benefits & Barriers of Incorporating Economic Analysis Findings Into SH&E Investment Proposals

Showing a relationship between investments in SH&E practices and economic performance can be an elusive undertaking. The question that continues to challenge SH&E specialists is, "Do investments in practices intended to confront and manage SH&E issues contribute to economic performance?"

Many practitioners and academics say yes; (Goetzel, 2005; European Agency for Safety & Health at Work, 2004; ASSE, 2002; Jervis & Collins, 2001; Smallman & John, 2001). Many internal stakeholders say no (Dorman, 2000; Shapiro, 1998). They are skeptical about how SH&E economic analyses are conducted, specifically how cost and potential profitability data are collected, calculated, analyzed, interpreted and reported.

No compelling research provides a definitive financial answer. Nevertheless, in the absence of evidence-based research, the reality is that SH&E investments do not routinely create opportunities to make money; however, at the same time, the opposite stance that SH&E investments seldom provide a financial pay-off is also incorrect. There should be no denying that investing in SH&E practices has always been a complicated proposition with real methodological challenges and economic implications. Even so, most firms tend to invest in SH&E practices despite their economic impact, but they should do so knowingly.

Typically, companies view their SH&E and economic performance as separate lines of attack operating independent of and usually in opposition to one another. However, the actual interdependence between these concerns increasingly highlights the need to show some type of an economic relationship.

Generally, SH&E specialists have not incorporated economic analysis to show how investments in these practices contribute to economic performance. As a result, management tends to look at SH&E concerns as a necessary cost of doing business, expects little economic payback, leaves safety out of the firm's competitive business strategy, and excuses from internal stakeholder expectation that the function justify its internal and external affairs from an economic perspective. This is not a viable perception for internal stakeholders to bring and hold onto during the investment allocation decision-making process. Only a focus on the results of economic analysis can provide internal stakeholders with the necessary information to set investment allocation priorities.

The emphasis on the results of economic analysis does not reflect any intention to deemphasize the importance of ensuring regulatory compliance. Concern for compliance rightly exists, and employing economic analysis is not intended to replace compliance applications.

However, a compliance-only focus should not be expected to yield positive financial returns. Alternatively, what economic analysis attempts to do is to go beyond compliance in ways that provide pertinent quantitative and qualitative economic information about how a company's organizational activities (e.g., products, technologies, processes, services) create SH&E issues and how strategic investments in innovative practices to address these issues might offer financial opportunities.

As a rule, decisions regarding investment allocation typically hinge on a firm's reputation, its competitive strategy, its research and development capability, its technology resources, and the human means to productively use and protect organizational resources. The analysis used to reach these decisions tends to be heavily slanted on economic aspects; therefore, how well economic analyses are conducted and how well the findings support the organization's competitive strategy will usually affect how investments are allocated.

During the past 25 years, many practitioners have come to see that existing and emerging SH&E issues, such as occupational injuries and illnesses, environmental incidents, natural and man-made hazardous exposures, stringent regulatory requirements, pressure from nongovernment interest groups concerning sustainable resource development and use, and long-term contingent liabilities resulting from past operations, are also impacting competitive performance and are increasingly affecting how investments are allocated within an organization.

The real dilemma facing decision makers is how to make investment decisions to address SH&E issues in the absence of sound quantitative economic information. Without economic analysis results, which detail the estimated cost and potential profitability of investments, even the most enthusiastic

Abstract: *This article examines economic analysis as a way of making a business case for SH&E issues and practices. The authors explain that the issue of making a business case for SH&E is grounded in past work and describe what is needed to move this effort ahead. The rationale, benefits and barriers to incorporating economic analysis findings into SH&E investment proposals are then discussed, as is a blueprint for constructing an SH&E economic analysis model. An example providing logic for using net present value is offered as well.*

SH&E internal stakeholders will have no means to objectively make fiscally prudent investment allocation decisions.

Several beneficial outcomes should be expected and leveraged when SH&E economic analyses are effectively conducted (Veltri, et al., 2003a, b). These include the following:

1) a refined understanding of the products, technologies, processes and services that tend to drive SH&E life cycle costs;

2) a more complete and objective data set on life cycle costs and profitability potential of SH&E investments, enabling improvements to product, technology, process and service designs;

3) an enhanced way of determining which SH&E management strategies and technical tactics to pursue and what level of investment will be required;

4) a new investment analysis structure in which developing SH&E practices becomes the normal strategy for making business decisions, and in which business needs become a way of making SH&E decisions.

Despite these leveraging opportunities, some internal organizational barriers must be overcome when applying economic analysis to SH&E. Examples of internal perceptions that SH&E specialists should expect to confront include the following (Veltri, et al., 2003a, b):

1) an operations-level perspective that SH&E issues linked to the firm's existing processes are primarily compliance based and play a small part in the company's investment allocation decision process.

2) a design-engineering-level perspective that the existing strategy and methodology for performing economic analysis of SH&E issues and practices which affect new product, technology and process designs are qualitatively and quantitatively immaterial for enhancing design changes;

3) a senior-level executive perspective that proposals for investments in practices to counteract SH&E issues are not financially structured and reported in a manner that allows the SH&E function to compete with other investment proposals.

These internal organizational barriers are significant and need to be overcome in order to compete in for investment allocations. The strategy expected to be the most effective in achieving this is to employ economic analysis in a manner that discloses the internal and external SH&E-related costs throughout the productive/economic life cycle of the organization's existing, new and upgraded activities, and reveal the financial impact (i.e., cost and profitability potential) that investments in SH&E practices have on these organizational activity designs.

A Blueprint for Constructing an SH&E Economic Analysis Model

Economic analysis provides a technique to use when economic considerations dominate and drive operational decision making, and cost and profitability potential are the criterion for choosing which SH&E issues to address and in which solutions to invest. An abridged life cycle costing method featuring net present value financial analysis is the recommended structure for constructing an SH&E economic analysis model. Several such methods have been described in the literature (Graedel, Allenby & Comrie, 1995), ranging from primarily qualitative approaches to quantitative ones in which expert judgment, a limited scope and a system boundary keep the life cycle assessment effort manageable.

Experience demonstrates that life cycle assessment for a complex manufactured product or an industrial manufacturing process works most effectively when it is done semiquantitatively and in modest depth. Unlike the full method, an abridged method is less quantifiable and less thorough. It is also more practical

Economic Analysis Terms

Economic analysis: A technique for comparing two or more mutually exclusive alternatives under given assumptions and constraints. It takes into account the opportunity costs of resources employed and attempts to measure in monetary terms the private and social costs and benefits of a project. Economic analysis in SH&E management is used when economic considerations dominate and drive the firm's operational decision-making and cost and profitability potential are the criterion for choosing among which SH&E issues to confront and manage and which alternative solutions to make selected investments.

Net present value: A method used in evaluating SH&E investments whereby the net present value of all cash outflows (such as the cost of the SH&E investment) and cash inflows (returns) is calculated using a given discount rate/hurdle rate.

SH&E capital budget: A program for financing long-term outlays such as acquiring safety, health and environmental equipment, areas and facilities.

Cost-benefit analysis: A method of measuring the benefits expected from a SH&E decision, calculating the cost of the decision, and determining if the benefits outweigh the actual costs. Some firms use this method to decide on purchasing long term capital outlays and determining the efficacy of certain SH&E program efforts.

Economic life: The equivalent to the estimated amount of time that investments in the system can be expected to have economic value or productive uses and the estimated amount of time recurrent savings and reduced contingent liability can be achieved without having to reinvest as the initial investment ages.

Hurdle rate: The required rate of return, in a discounted cash flow analysis, that the firm is using for judging investments.

to implement. An abridged assessment will identify the majority of the useful SH&E actions that could be taken in connection with corporate activities, and the amounts of time and money consumed will be small enough that the assessment has a good chance of being executed and its recommendations implemented. The foundation for the abridged architecture is based on the unabridged framework developed by the Society of Environmental Toxicology and Chemistry (1991).

Present-value financial analysis provides the final link in the architecture. This method provides the most reliable means of comparing the financial performance of mutually exclusive alternatives (Newman, 1983). Present-value financial analysis helps to delineate the long-term financial impact of SH&E investments by presenting the after-tax cash flow and the present-cost value of the investment over a sufficient time horizon.

The rationale for using net present value financial analysis is that many of the traditional financial analysis techniques employed by SH&E specialists, such as payback and rate of return on investment, fail to take the time value of money into consideration. Although these are useful tools in analyzing investment decisions, their exclusive use can result in incorrect decisions, such as accepting project proposals that lose money or rejecting proposals that may represent financial opportunities.

Figure 1 provides an architecture for an SH&E economic analysis model and specifically outlines ways to 1) define and set the boundaries necessary for managing the economic analysis; 2) conduct an abridged life cycle inventory analysis and impact assessment of existing SH&E issues and proposed alternatives—from upfront analyses, acquisition of capital and permits, through resource and material use, disposal and closure; and 3) conduct postimplementation reviews to assess whether the results of implemented solutions are in reasonable agreement with the estimated projections. This blueprint does not reflect all of the factors being considered when making decisions about the economic aspects of SH&E, but it points at and reveals a way of thinking that strongly influences investment decision makers.

Stage I: Analysis Definition & Boundary

Defining the SH&E economic analysis strategy and setting its structural boundaries are key aspects of the economic analysis. This initial stage, as outlined in Figure 1, should consider specifying the type of analysis to be conducted. Specifically, one should attend to the following components: 1) a description of the existing, upgraded or new product-technology-process or service system; 2) the system's expected economic life (i.e., the equivalent to the estimated amount of time that investments in the system can be expected to have economic value or productive uses, and the estimated amount of time recurrent savings and reduced contingent liability can be achieved without having to reinvest as the initial investment ages); 3) the

This model is comprised of three stages and provides an architecture for conducting an economic analysis of SH&E practices.

Figure 1

SH&E Economic Analysis Model

SH&E Economic Analysis Stages

Stage 1: Analysis definition and boundary

Specify type of analysis/application

1.1.1 Existing, new or upgraded activity (e.g., product, technology, process, service application)

State the design and organizational intent of the analysis

1.2.1 Purpose and objectives
1.2.2 Scope, boundaries and analysis limitations
1.2.3 How results will be used for decision making

State the methods and procedures of the analysis

1.3.1 Data collection, analysis and interpretation procedures
1.3.2 Reporting results

Identify key personnel for participation

1.4.1 Selection criteria (integrated and cross functional representation)
1.4.2 Specify competencies/capabilities
1.4.3 Specify role and responsibility

Construct process flow diagram(s) existing and new

1.5.1 Depict upstream inputs and downstream outputs
1.5.2 State existing and new system composition and history
1.5.3 Current and potential performance problems
1.5.4 System capabilities and limitations
1.5.6 Outcomes expected as a result in change

State existing organization means for controlling impacts

1.6.1 Financial, operational, technological means

Stage 2: Inventory analysis and impact assessment

Conduct inventory analysis of existing and proposed change

2.1.1 Identify and quantify known resource inputs (energy, water, capital resources, material, labor)
2.1.2 Identify and quantify known resource outputs (air emissions, water effluents, waste, contingent liability)

Conduct impact assessment

2.2.1 Qualitative and quantitative classification, characterization and valuation of impacts to ecosystems, safety and health, natural resources

Stage 3: Postimplementation look-back

Review results of implementation

3.1.1 Every 3 to 12 months
3.1.2 Factors to consider: user satisfaction (e.g., involvement-usage, benefit-cost profit relationship); strategic impact and effectiveness (e.g., decision-making relevance, alignment with financial and management information systems)

Architecture

Abridged life cycle costing method

Combining

Net present value financial analysis

In any investment in SH&E practices, the results of implementing changes should be in reasonable agreement with estimated projections.

firm's hurdle rate (i.e., the required rate of return in a discounted cash flow analysis that is used when judging investment proposals); and 4) the existing and potential SH&E issues (e.g., CO_2 or NO_x emissions, solvent use) and impacts (global warming potential, acidification, injury) that are linked to the organizational activity under analysis.

To keep the analysis focused, its design and organizational intent must be stated upfront. Components to consider include the following: purpose and objectives, key assumptions and analysis limitations, and how information will be used to drive decision-making capabilities. One should also consider specifying the methodology suggested for performing the analysis (e.g., data collection, analysis and interpretation, and reporting procedures); such information should be made transparent and stated upfront.

Next, an integrated project team should be created to participate in the study. These individuals will be supportive personnel and their assistance is critical. They must receive appropriate advisement and encouragement in order to perform as expected. The team should be cross-functional and possess the following skills: financial, design and process engineering, operations, facility management, procurement, legal, SH&E and community relations.

The next component in this stage is to construct process flow diagrams of existing organizational activity and the proposed change. The diagram should depict upstream inputs and downstream outputs, the existing and new system composition and history, current and potential performance problems, existing and new system capabilities and limitations, and outcomes expected as a result of a change.

Stage II: Inventory Analysis & Impact Assessment

An inventory analysis is conducted during this stage. This involves, for example, identifying and quantifying known resource inputs such as energy, water, capital, resources, materials, labor and outputs such as air emissions, water effluents, waste and contingent liability. An impact assessment is also performed, which involves, for example, qualitative and quantitative classification, characterization and valuation of impacts to ecosystems, human safety and health, and natural resources based on the results of the inventory.

The team may also provide decision makers with estimates of the organization's level and means to control or improve the existing SH&E issue. This will add a level of robustness to the analysis. A chief factor to assess is the firm's funding capability, that is, the existing level of funding available to control or improve the SH&E issue. A high rating level of funding suggests that the organization has the financial means to effectively control or improve the issue while a low level suggests that the firm has little financial means to affect the issue in the immediate future.

Another factor is human-operational capability. This refers to the existing level of human-operational wherewithal to control or improve the SH&E issue. A high level of wherewithal suggests that the organization has the human means and capability to control or improve the issue while a low level suggests that the firm has little human-operational means to affect the issue in the immediate future.

Available technology is another consideration. A high level of available technology suggests that the firm can acquire technology as a way to control or improve the issue while a low level of available technology suggests that the firm has little technological means to affect the issue in the immediate future.

The use of impact models (e.g., risk and economic) helps guide decision making and operating actions to keep the inventory analysis and impact assessment structured; it also provides a picture of the life cycle process flow inputs and outputs linked to the activity being analyzed. Because of the breadth and depth involved in modeling risk impacts, the remaining commentary is directed only toward the modeling of economic impacts.

Stage III: Postimplementation Look-Back

In any investment in SH&E practices, the results of implementing changes should be in reasonable agreement with estimated projections. If a new technology was purchased because of potential reductions in cost and contingent liability, the company should assess whether those benefits are actually being realized.

If they are, then economic analysis projections would seem to be accurate. If not, a postimplementation review should be conducted to determine what has been overlooked. Perhaps economic projections were overly optimistic. One would need to know in order to avoid similar mistakes in the future.

To ensure that economic calculations and cost projections are realistic, everyone involved must know that results will be reviewed. Therefore, 3 to 12 months after a mutually exclusive alternative has become operational, and regularly afterwards, a postimplementation review should be conducted. Factors to be considered during this review include user satisfaction (e.g., involvement-usage, cost-benefit profit relationship) and strategic impact and effectiveness (decision-making relevance, alignment with financial and management information technology systems).

As a next step, let's look at the basic required steps in an economic analysis of an SH&E program.

Preparing Cost-Benefit Analysis

There are many types of economic analyses. The terms *cost effectiveness* and *cost-benefit analysis* are commonly mixed in the literature. To avoid confusion, let's distinguish between them. Cost-benefit analyses monetize—that is, put into dollar terms—both costs (e.g., inputs to a program) and benefits (e.g., consequences of a program). Cost-benefit analyses can, therefore, be used to compare the relative merits of several programs whether program-specific effects are common. For example, program X costs $1 for each $3.25 returned to the company by virtue of having implemented the program, while program Y costs $1 for each $4.67 returned.

In contrast, cost effectiveness analyses are generally used to compare alternatives that have a common, non-monetized effect. For instance, a cost effectiveness analysis might result in the following: Program X costs $1,500 per healthy day gained while program Y costs $1,350 per healthy day gained (Opatz, 1994; Nas, 1996; Drummond, Stoddard & Torrance, 1987).

Much knowledge is needed when performing economic analyses. They can be rather daunting tasks. However, the procedure is simplified in this discussion to provide a basic framework from which one could structure a cost-benefit analysis. Following is a short discussion of three essential components to any economic analysis: discounting, sensitivity analysis and model assumptions.

Timing & Discounting

Time bestows a value to money. One must account for the time-value of money in any economic analysis. One must also realize that for most prevention programs to show economic effect, they must run for several years. In this case, the economic analysis needs to account for the time-value of money.

Determining the time-value of either benefits or costs involves discounting the monetized benefit stream, as well as the cost stream that is due to the intervention program. Discounting is straightforward and easily accomplished in most spreadsheet software. Essentially, discounting is the present value of the benefits attributable to the program and the costs associated with implementing each year of the program, also in dollars.

For example, suppose $150 in benefits accrue attributable to a specific intervention program. Also suppose that the program produces $150 in benefits not just this year, but also next year (year two) and the year after (year three). The value in today's dollars of the benefits of this 3-year program would be determined using the following formula:

$$PV = \$X \ / \sum_{i=1}^{n} (1+d)^{n}$$

where: PV is the present value of some dollar amount X, in any given year
d is the discount rate raised to the power of each year in the program

Thus, for a 3-year program, with a discount rate of 3% and a $150 worth of benefits in each year, the present value of all 3 years of benefit streams would be calculated as:

$$PV_B = \$150/(1+0.03)^1 + \$150/(1+0.03)^2 + \$150/(1+0.03)^3 = \$424.29$$

One would conclude that the present value of the benefits of this program, discounted at 3% is $424.29. Note the difference between the discounted sum of $429 and the straight linear sum of $450. This difference is due to the differences in discount rates and is known as the time value of money. Generally, the higher the discount rate, the lower the present value.

When one identifies the benefits of an intervention program and the costs of its implementation, then monetizes them, the ratio of the present value of the benefits to the present value of the costs is referred to as the cost-benefit ratio of the program.

Sensitivity Analysis

How does one determine the proper discount rate? Said differently, what is the best way to monetize the benefits attributable to their intervention program and to account for the time-value of money? Because many assumptions lead to the estimated values used in any economic analysis, sensitivity analyses are necessary. A sensitivity analysis is a process whereby a range of values or estimates for particular parameters is used as opposed to a singular value. The hope is that the true value, while difficult to know with certainty, is within the range of estimated values.

For instance, the cost of capital to a firm may be 5% this year and 5.75% next year. How does one properly incorporate such variation into the cost-benefit analysis? The answer is to use a sensitivity analysis and discount the streams of benefits and costs using at least two interest rates. For instance, the earlier example used 3% as a discount rate, which may be considered the low estimate. Also, one might desire to use 6% as a high estimate. Using 6%, the present value of the earlier example is $400.95.

Similarly, suppose it is unknown whether the benefit flow is really $150. It may be as high as $200 if one were to use an alternative method to monetize benefits, or an alternative estimate of benefit magnitude, or of the program's ability to achieve success. In this case, the sensitivity analysis would include at least two discount rates, and possibly two or more estimates of the benefits.

So, whether the program is cost beneficial may ultimately depend on the discount rate used or the methods used to monetize benefits or calculate the costs. The likely result will be worst-case and best-case estimates, with the actual results falling between those figures. Keeping accurate track of the estimates used in the analysis is the next topic of discussion.

Model Assumptions

As suggested, many assumptions must be made in each economic analysis. Best practice would suggest that one should state these with clarity. Items that need to be tracked include the following: discount rates used; dollar estimates of each benefit attributable to the intervention programs; costs required to implement the intervention programs; and whether the analysis is done from the perspective of society, the employer, the employee or the insurance provider.

For example, the following economic analysis adopts the perspective of the employer. The seven steps illustrate how one might determine a cost-benefit ratio for a 1-year HazCom intervention program. As a disclaimer, this is an outline and is not an exhaustive example of how to identify and monetize all possible benefits and costs.

Step 1: Initial Assessment

Step 1 involves identifying who is exposed to worksite chemicals by virtue of their position descriptions, the degree to which they are exposed and the nature of their exposure, and what program content might look like. This step can be thought of as an initial financial assessment of the prevailing exposures in the organization before specific SH&E training and educational programs take place. That is, step 1 targets specific exposures for remediation and, thus, establishes the baseline against which the program will be evaluated following its implementation.

Step 2: Monetize the Exposures

Step 2 involves determining the cost to the organization due to the exposure(s) targeted for remediation in step 1. To facilitate the sensitivity analysis, the SH&E practitioner should collect both high and low estimates for the cost of each exposure to the organization. The practitioner should identify and quantify these costs as either direct or indirect costs.

Direct costs include medical and legal claims associated with the adverse outcomes associated with the illnesses or injuries associated with inadvertent overexposures of the employee. Indirect costs include such items as hiring and replacement costs, turnover and absenteeism, lost time due to inefficiencies of new employees, production losses, cost of administrative handling of the claims including supervisor involvement in hiring and retraining, and the costs of lower morale and higher stress.

Estimating these costs is not easy since, as noted, some companies may not collect such data in a concerted, thoughtful way. As a result, it may be difficult to reliably identify and monetize each type of direct or indirect cost. Still, one can likely generate best estimates from past records indicating how much exposures have typically cost the organization. Since average values are more susceptible to extreme individual values, try to use the median cost of the examples.

For example, historical data, conversations and past experience may reveal the median cost of a chemical spill in a given department to be approximately $5,000 in direct medical costs to the organization and another $10,000 in indirect costs. Although this estimate may not be a perfect monetization of the true financial burden of a chemical spill, it is a good start and may indeed reflect the best data available. Establishing a high- and low-end estimate is central to conducting a sensitivity analysis. In turn, a proper and thorough sensitivity analysis will add robustness and credibility to the overall cost analysis.

The bottom line in step 2 is that the past costs of injuries and illnesses will adequately proxy the benefits attributable to the intervention program because presumably the company will not experience the same incident experience once employees have been better trained and educated. As such, an organization is better able to avoid the same frequency and same severity of its past experience. As will be explored shortly, improving on an organization's past incident experience will become the bases of how one estimates the benefits of any SH&E program.

Step 3: Establish the Present Value of Program Costs

Step 3 involves estimating the present value of both the direct costs of the involvement in the HazCom program as well as the indirect costs of the supporting activities and materials that will be involved in the HazCom program for each year of its lifetime. In this step, as in step 2, the SH&E practitioner should obtain both high and low estimates for each specific cost. The direct costs of involvement include calculating the loaded hourly salary; indirect costs include estimating the per-person cost to the organization for its involvement in each phase of the HazCom program.

Next, costs are annualized and summed. For instance, in the case of an organization that uses a zero-based budgetary process, even though the program may require a multiyear implementation, all costs would be for the current budget year only.

Finally, a discount rate is identified and used to establish the present value of the annualized costs of the multiyear program. One should use at least two discount rates in all cost analyses, effectively creating another level to a sensitivity analysis. The first discount rate is traditionally the risk-free rate on U.S. T-bills. The second should be a rate chosen by management that perhaps more accurately reflects the cost of capital to the organization.

It should also be noted that in addition to varying the individual cost-benefit estimates and using at least two discount rates to establish the present value of the cost and benefit streams, a more thorough and defensible sensitivity analysis will vary the magnitude and frequency of various program costs and the subsequent expected benefits, among other components of the specific program.

Step 4: Evaluation

Step 4 involves a reevaluation of the costs to the organization caused by the exposures or hazards that exist after the HazCom program has been executed. Then, each benefit must be monetized. Presumably, the exposure level that remains following the

Why Use HazCom?

Hazard communication is indeed a standard compliance program required by federal law. It is also one of the most designed and implemented of all SH&E programs and one of the most cited standards by OSHA in any given year.

Its choice as an example for economic analysis is grounded by the fact that it is a widely known program that requires organizational funding. Also, HazCom makes for a good example for economic analysis precisely because it is required by law. The fact that a program is required by federal law has not been a guarantor of its budgetary existence.

Illustrating the economic aspects of a HazCom program should empower SH&E practitioners to make fiscially prudent decisions and be motivated to offer senior-level executives an improved rationale for supporting such programs from an economic perspective, not simply because they are "required and we better have them in case we get inspected," rather, because they may make good business sense, they improve safety and health, and they may positively impact the bottom line.

Figure 2

Calculating a Cost-Benefit Ratio for a HazCom Program

STEP	ACTIVITY	RESULT
1	Organization-wide HazCom exposure assessment.	Of 100 employees, approximately 25% are at risk of chemical handling exposures. These employees should be educated and trained in the safe handling, use, disposal of each chemical they're required to use.
2	High and low estimated per person cost to the firm of the exposure; e.g., safe chemical handling. Use data from past WC claims or other healthcare utilization records and other company data as available to identify what costs have been in the past => avoided past costs = benefits of your program.	***Direct*** => high =$25,000/person/year || low = $15,000/person/year ***Indirect*** => high = $50,000/person/year || low = $30,000/person/year **TOTAL = (*direct + indirect*)** => high = $75,000/person/year => low = $45,000/person/year
3	Estimate costs of **your involvement** for the year + **supporting activities & materials**. Assume all 25 employees at risk of chemical over-exposures will participate in each of the 4 intervention programs and that your total time is approx. 800 hours for the year. Calculate the present value of both the high and low cost estimates to implement all HazCom intervention programs. **PV_C = Present value cost**	***Direct*** => (**$**13.94/hour)(800 hrs./year) = $11,152/yr. ***Indirect*** => costs due to your programming, materials, supplies, opportunity costs, etc. **Stress management, basic HAZCOM** => high $55/person || low $22/person **Chemical spill training** => high $225/person || low $75/person **Chemical labeling training** => high $135/person || low $22/person **MSDS management** => high $8/person || low $4/person **TOTAL = (*direct + indirect*)** => high = $21,727/25 people/year => low = $14,227/25 people/year **HIGH PV_C** = $\$21{,}727/(1+.04)^1 + \$21{,}727/(1+.04)^2 + \$21{,}727/(1+.04)^3$ = **$60,294** **LOW PV_C** = $\$14{,}227/(1+.04)^1 + \$14{,}227/(1+.04)^2 + \$14{,}227/(1+.04)^3$ = **$39,481**
4	Upon reassessment of company data, determine the number of avoided cases due to the HazCom program.	25 employees are trained and evaluated, assume no change in injury or illness rate the first year, but 2 injuries are is avoided the second year, and 2 more in year 3 => 0 avoided cases in year 1, 2 avoided cases in year 2 and 2 avoided cases in year 3.
5	Calculate the present value of both the high and low benefits estimates expected due to avoided cases. **PV_B = Present value benefit**	**HIGH PV_B** = $0(\$75{,}000)/(1+.04)^1 + 2(\$75{,}000)/(1+.04)^2 + 2(\$75{,}000)/(1+.04)^3$ = **$272,032** **LOW PV_B** = $0(\$45{,}000)/(1+.04)^1 + 2(\$45{,}000)/(1+.04)^2 + 2(\$45{,}000)/(1+.04)^3$ = **$163,220**
6	**BENEFIT/COST = PV_B / PV_C**	**HIGH B/C => $272,032/$39,481= $6.84 to $1** **LOW B/C => $163,220/$60,294= $2.71 to $1**

HazCom training and educational intervention is measurably less than it was when initially assessed (step 1).

Several methods are available by which one might proxy an improved exposure level following the implementation of any given SH&E program. For example, a lesser exposure level might be indicated by the value (economic or intangible) to the organization of increased knowledge and skill among its exposed employees, decreased workers' compensation claims, a decreased experience rating, fewer lost-time accidents, more near-hit reports, higher job satisfaction, improved morale, less absenteeism, less presenteeism (coming to work despite being ill and, therefore, not fully functioning), a quantifiable decline in the number of reportable injuries and/or illnesses, etc., each directly due to the HazCom program. Associating a dollar value to each benefit that closely reflects the cost of these benefits to the company monetizes them and allows them to be used in the calculation of a cost-benefit ratio. In this way, step 4 is designed to capture, quantify and monetize the improved risk position of the organization due to the HazCom intervention program.

Step 5: Establishing Present Value of Program Benefits

Once the benefits of the HazCom program have been identified, the next step is to calculate the present value of each benefit. Again, it is prudent to establish both high and low estimates for each benefit attributable to the organization by virtue of the HazCom program.

Once monetized, and once the SH&E practitioner determines when each benefit occurs over the program's lifetime, the benefit stream should be discounted into today's dollars, that is, the present value of the benefit stream must be calculated. The same discount rates used to calculate the present value of the cost stream should be used to determine the present value of the benefit stream.

Step 6: Cost-Benefit Ratio Calculation

This step involves calculating two distinct cost-benefit ratios for each discount rate used: first, calculate a high ratio, by dividing the present value of the high estimate of the benefits identified in step 5 by the present value of the low estimate of the costs identified in step 3. The second ratio is the low cost-benefit ratio, which is derived by dividing the present value of the low estimate of the benefits by the present value of the high estimate of the costs. Figure 2 presents an example of these steps given one discount rate.

Conclusion

Questions and uncertainties related to SH&E issues, practices and investments create business challenges for a company's internal stakeholders. One must understand the existing circumstances

When one identifies the benefits of an intervention program and the costs of its implementation, then monetizes them, the ratio of the present value of the benefits to the present value of the costs is referred to as the cost-benefit ratio of the program.

that drive these issues, their impacts and costs, and to know how to allocate the investment outlays necessary to confront and manage these issues and how to evaluate the efficacy of those investment outlays. One common question is what should an SH&E practitioner do in the event that of a negative economic analysis?

Most organizations do not understand which products, technologies, processes or services provide more or less value comparative to their costs. Traditional SH&E costing systems tend to suffer from imprecise cost collection, analysis and interpretation procedures and distorted cost reporting, have little transparency regarding what comprises their costs, fail to consider the financial returns that can be expected later from the investment and, thus, lose their decision relevance. ■

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