

Phase II: Develop and Test General Strategy Components

Introduction

The purpose of Phase II of the Value of the Industrial Hygiene Profession project was to identify and evaluate possible elements of the ***IH Value Strategy***. This was considered critical if the ***Strategy*** was to be credible and effective in capturing and demonstrating the value that IH adds to the business.

The information contained herein lays the foundation for the ***Overarching IH Value Strategy*** described in the Phase V section of this report, and for the *Qualitative* and *Quantitative Approaches* described in the Phase III and IV sections of this report, respectively. Most of the key findings are captured here, but some are more appropriately discussed in Phases III, IV, and V. Also, it is important to note at the outset that many of the findings herein resulted from study, observation, experience, and anecdotal information, and do not reflect statistically reliable survey results.

Fundamental Concepts Incorporated into the *IH Value Strategy*

Definitions

The ***IH Value Strategy*** is based on existing concepts and models. In general, a model is an abstraction of a real-life system with the purpose of increasing understanding of that system. It is also a representation of a system, which provides a means for investigating the components of the system. Of import to this endeavor is a specific type of model—the business model—which has been described in varied ways.

Peter Drucker, the father of modern management, suggests that the business model must identify the customer, what the customer values, and how the firm makes money in the business. In other words, what is the underlying logic that explains how value can be delivered to the customer? Business models have been promoted as a way to explain how a firm or enterprise works—i.e., how the individual pieces of the business fit together. Business modeling has also been characterized as the managerial equivalent of the scientific method; it starts with a hypothesis, tests that hypothesis, and revises actions as needed. (Magretta, 2002).

Models can be presented in physical, graphical, or mathematical terms. Graphical models consist of lines, symbols, shapes, or charts and include Pareto Diagrams, Ishikawa Diagrams, and break-even charts. Formulas and equations are the mainstay of mathematical models and are frequently used in business to aid in decision making or planning activities. Examples include linear programming, cost benefit analysis, and return on investment calculations.

A strategy is a method or plan that combines a set or series of activities to accomplish a specific predetermined goal or result. Armed with a business model that accurately describes the operation of the business process and how various components of the business interact (including IH programs, projects, and interventions) as a foundation, a strategy can be developed that enables IH practitioners to identify and present the value of IH within the context of the business operation. This is the gist of the current project.

Beyond the specific definitions and the presentation format, a successful business strategy must create a heuristic reason that connects technical potential with the attainment of value. To accommodate this need, this project has provided both mathematical and graphical models that define the principal customer as the business enterprise and examine the relationship between the technical role of the industrial hygienist and the economic (tangible and intangible) value of their contributions. The method for this project, as is the case for any scientific method, was to hypothesize the most appropriate elements of the *Strategy*, test them under real world conditions, and revise them as necessary to ensure accurate and effective demonstration of the value of the IH profession.

The Fundamental Role of Risk

Risk is one of the first components necessary to derive the value of the industrial hygiene profession. The focus of the industrial hygienist is on the reduction of risk to worker health from hazards found in the work environment. Uncontrolled or insufficiently controlled hazards associated with materials and processes may create dangerous conditions to which workers should not be exposed. Industrial hygiene is the discipline of anticipating, detecting, recognizing, evaluating, and controlling such occupational health risks. Through education, training, and experience, an industrial hygienist learns what hazards can be expected from specific types of operations and how to determine if they are present, understand the likely impact of those hazards, evaluate the degree of the risk to worker health, and recommend measures to control or eliminate the risks.

Through prescribed actions to manage occupational health risk, the IH program will protect workers from biological, chemical, and physical hazards, which include ergonomic, noise, and radiation hazards. This action, which can take the form of a single focused intervention or an entire IH program, becomes another major component of the overall strategy to demonstrate the value of the profession. These two areas, risk reduction and IH activities and/or programs, will drive the value proposition.

What We Mean By “Value”

With a clear idea of the type strategy that this project will provide and the role of the IH profession, the next challenge is to define value. Value is a relative term, with meanings grounded in multiple disciplines. For the purposes of this discussion, the definition of value will be limited to those found in economics, accounting, and general business.

In economics it is traditional to separate the concept of value into value that expresses the inherent usefulness of an object and value associated with the power of purchasing other goods. The first is called *value in use*, the latter *value in exchange*. Value in use is not an intrinsic quality of a commodity, but its capacity to satisfy, directly or indirectly, needs or desires. Value in exchange is the worth of commodity in terms of its capacity to be exchanged for another commodity, which is usually money. This concept is referred to as market value. In classical economics the existence of use value was a prerequisite for commodities to have value in exchange.

In accounting, value has been defined as the monetary worth of services provided, a specific asset, group of assets, or the business as a whole (Barron's, 2005). The framework for measuring value in the United States can be found in General Accepted Accounting Principles (GAAP). GAAP include the standards, conventions, and rules that accountants follow when recording and summarizing transactions and when preparing financial information. Included in the GAAP are a series of Principles to help guide the

recording and reporting functions to best ensure the transparency, comparability, reality, and acceptability of the financial results.

In management, business value is often an informal term that includes all forms of value that determine the health and well-being of the firm. Business value expands beyond economic value to include other types of value. For example, employee value, customer value, supplier value, channel partner value, alliance partner value, managerial value, and societal value. Many of these are not directly calculated in monetary terms nor are all these examples pertinent to this work.

Customer value is one of the more important business values for consideration in determining the value of the IH contribution. In this context it would be defined as the value received by the end-customer of the IH action to control risk. The end customer can include the organization's external clients or individuals within the organization in the business process. The benefit is envisioned as utility, quality, benefits, and customer satisfaction.

The organization can also be viewed as a network of internal and external relationships. Value in this context is described as value networks or value chains. Each point in the network has an interest in the business process, such as a stakeholder group, a resource, end-consumers, interest groups, regulators, or the environment itself. To create value for the organization, there is a collaborative, creative, and synergistic process among the groups. If the organization is viewed as a network of value creating entities (in this case, the industrial hygienist) then the question becomes how each point in the network contributes to overall firm performance. While it would be beneficial if this value could be monetized into a single measure, it is clearly not feasible.

As a final note, Warren Buffet provides a most insightful definition: "*Price is what you pay. Value is what you get.*" Whether value is measured in accounting, economic, or business terms, the value of the IH profession is determined by what the organization gets from the work of industrial hygienists; it is this impact or the effect they have on the organization.

The next components of the strategy can be formulated using these definitions and answering one question—what is affected as a result of the industrial hygiene action? By reducing risk, the health of the employees will change, the business process will change, and the work of the industrial hygienist will change.

How can value be evaluated?

Understanding the IH function and the effect within the organization provides useful information but does not provide a thorough accounting of the value or worth of that function. The definition of value provides some insight, but the method of estimating that value remains to be determined. One method to measure that value is through evaluation studies focused on the specific projects or programs undertaken by the profession. In broad terms, an evaluation can focus on the strategic, technical, economic or financial aspects of a project. Technical evaluations determine the technical appropriateness of equipment, material, or the entire system. While this is a necessary evaluation, it is not sufficient to determine the contribution of IH work to the enterprise.

Economic evaluations are systematic appraisals of both the costs and consequences of an action implemented at the worksite. These are normally conducted to determine the relative economic efficiency, either allocative or technical efficiency, of specific actions. The National Institutes of Health (NIH, 2007) states the aim of economic evaluations is

to ensure that the benefits from a program or action are greater than the opportunity costs of that program. Allocative efficiency assesses competing programs and judges the extent to which they meet objectives, and technical efficiency assesses the best way to achieve a given objective.

A full economic evaluation compares the costs and consequences of two or more actions. A full economic evaluation is required to gain valid information on efficiency—that is making the best use of the available resources of the employer. The methods to conduct a full economic evaluation include cost-benefit analysis, cost-utility analysis, cost-effectiveness analysis, or cost-minimization analysis. Cost-benefit analysis is the most commonly used method from an employer perspective and determines allocative efficiency. This method expresses all costs and consequences in the same unit, which is usually money. Cost-effectiveness analysis expresses the costs and consequences in different units; for example, cost per health outcome. However, the denominator can be other units as well, such as cost per employee or cost per unit of production. With this flexibility, the method can be used to determine technical efficiency.

In addition to a full economic evaluation, a partial evaluation study can also be conducted. This method still considers both costs and consequences, but does not compare alternative interventions, relate costs to benefits, or allow for determination of efficiency when using a single method. The five types of partial evaluations are: cost comparison or cost analysis, cost outcome description, cost description, outcome description, and cost of illness studies. Any of these types can be used as input for a full economic evaluation.

Evaluation techniques can also be categorized as using either positive or normative methods. Positive methods are based on measurable factors, while normative methods are based on factors more difficult to measure. Positive evaluation methods are grounded in positive economics, which is based on measurable factors such as costs, efficiency, or prices. Normative evaluation methods are concerned with issues of welfare, ethics, value judgment, business values, and equity. Consideration of full economic evaluation suggests that these studies can be positive evaluations. However, the consequences should be sufficiently robust—including the effect on business values and goals—to accommodate normative studies as well.

These techniques involve making quantitative evaluation of three key considerations: profitability, sustainability of operations, and the opportunity cost of not investing elsewhere (Brannock, 2004). In broad terms, profitability assumes that expected benefits exceed costs. Sustainability addresses the need for the productive process remaining competitive. Finally, it is assumed that investments in internal operations will create a larger rate of return than outside investing. It is at this point that the importance of financial measures becomes apparent. According to Brannock, economic evaluation provides “fundamental quantitative tools for financial evaluations of business case alternatives.”

Each evaluation perspective can be independently employed. However, the true power is a combination of technical, economic, and financial analysis. The technical feasibility of an IH action will be determined in the early stages of controlling risk and it is assumed that if it is not technically feasible, it will be excluded from further consideration. A strategic evaluation ensures that the project is consistent with the output objectives of the firm. The economic evaluation will explore the costs and benefits of the action and the outputs from that evaluation are often presented as financial measures. A financial analysis will help determine if the goal of maximizing value has been met.

Understanding Financial Measures

The following are common financial measures used to evaluate business investments within a corporate or commercial enterprise, including short- and long-term investments. Within this context, IH activities or programs are the investments being evaluated, whether they affect capital investment or working capital management. These measures describe the effect that an investment has on the financial condition of a company and the impact on profit. They are tools used to assist management in the allocation of limited resources between competing opportunities.

Cash Flow

Cash flow is the basis for deriving the majority of financial measures for the business case and is often the most challenging. Calculating the cash flow involves not only estimating the amount of expected benefit or cost, but also projecting when the benefit or cost will be incurred. Translating benefits and costs into cash flow statements can be challenging. Each benefit or cost identified from the previous sections leads to either an expected cash flow result, or will be assigned a value in cash flow terms. Cash flow entries should include non-cash charges such as depreciation and reflect after-tax values.

The cash flow statement provides a list of the investment outflows (costs and expenses) that will be required, the inflows (monetized benefits) the project will produce, and the time those inflows will occur during the analysis period. The following two tables provide an example of a cash flow statement associated with a “status quo” option and another one for a proposed option (Tables II-1 and II-2). These examples provide the net cash flow for each period considered as they generally serve as the starting point for budgeting and business planning activities. Estimations may be influenced by a number of factors, such as inflation, changes in tax rate, the strategic plans of the firm, and the overall economic environment.

Table II-1. Example Cash Flow Statement Associated with a “Status Quo” Scenario.

Status Quo Scenario		Full value cash flow in \$					
		Year 1	Year 2	Year 3	Year 4	Year 5	Total
Cash Inflows / Benefits and Gains							
Benefit item 1		45	66	165	228	279	783
Benefit item 2		428	588	641	699	777	3,133
Benefit item 3		781	677	620	755	819	3,652
Total cash inflows		1,254	1,331	1,426	1,682	1,875	7,568
Cash Outflows / Costs & Expenses							
Cost item 1		(90)	(87)	(87)	(95)	(110)	(469)
Cost item 2		(165)	(165)	(255)	(289)	(320)	(1,194)
Cost item 3		(975)	(777)	(645)	(700)	(710)	(3,807)
Total cash outflows		(1,230)	(1,029)	(987)	(1,084)	(1,140)	(5,470)
Cash Flow Summary							
Total inflows		1,254	1,331	1,426	1,682	1,875	7,568
Total outflows		(1,230)	(1,029)	(987)	(1,084)	(1,140)	(5,470)
Net cash flow		24	302	439	598	735	2,098

Table II-2. Example Cash Flow Statement Associated with a “Proposed Option” Scenario.

Proposal Scenario	Full value cash flow in \$					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Cash Inflows / Benefits and Gains						
Benefit item 1	120	170	150	275	300	1,015
Benefit item 2	500	615	704	755	812	3,386
Benefit item 3	866	876	812	900	1,010	4,464
Total cash inflows	1,486	1,661	1666	1,930	2,122	8,865
Cash Outflows / Costs & Expenses						
Cost item 1	(90)	(95)	(88)	(85)	(89)	(447)
Cost item 2	(400)	(350)	(387)	(320)	(300)	(1,757)
Cost item 3	(1,010)	(849)	(597)	(650)	(650)	(3,756)
Total cash outflows	(1,500)	(1,294)	(1,072)	(1,055)	(1,039)	(5,960)
Cash Flow Summary						
Total inflows	1,486	1,661	1666	1,930	2,122	8,865
Total outflows	(1,500)	(1,294)	(1,072)	(1,055)	(1,039)	(5,960)
Net cash flow	(14)	367	594	875	1,083	2,905

Incremental cash flow shows the difference between the status quo cash flow and the cash flow associated with implementing a new program or intervention. Simple cash flow does not consider uncertainty and the value of time.

Discounted Cash Flow (DCF) accommodates for uncertainty and the value of time by discounting the cash flow stream. Discounting adjusts the value of future cash flows by giving more “value” or weight to the near term cash flows and less “value” to those in the more distant future. It is important to know when you should include a discounted cash flow in your business case presentation. If the intervention or programs being considered cover long periods of time or if the magnitude of the inflows and outflows are different within each time period, a DCF should be presented. A DCF should also be presented if the timing of the cash flow from each intervention or program differs substantially within the analysis period.

Net Present Value (NPV) is the sum of the discounted values of a cash flow stream of net benefits (benefits – costs) over time. Mathematically it is represented as

$$\sum_{t=0}^n A_t (1+i)^{-t}$$

where A_t represents the annual net discounted cash flow of program or intervention and i represents the designated discount rate. NPV is a direct measure of the size of the benefits net of costs at the end of the analytic horizon that the business would have gained by undertaking the program or implementing the intervention, accounting for the time value of money. The discount rate for NPV and other measures calculated from the business perspective is usually the opportunity cost of capital for the business that is affected. The opportunity cost, also known as the minimum attractive rate of return (MARR) or hurdle

rate, is the market interest rate for lending and borrowing, and the risks associated with the investment opportunities. At the discretion of the analyst, discounting can be performed as though the cash flow occurred at either the beginning or end of a period. Again, because this may be a difficult rate to measure or obtain, it is important to conduct sensitivity analysis around this variable.

The NPV is a preferred merit measure because it is not affected by the planning horizon as long as the planning horizon is greater than or equal to the useful life of the program or intervention. The following table demonstrates the NPV calculation associated with a hypothetical program or intervention proposal.

Table II-3. Net Present Value Calculation.

Time Period	A _t	Discount Factor for 8% interest	Annual Discounted Value
0	-315.2	1.0000	-315.200
1	295.5	0.9225	272.599
2	248.2	0.8573	212.782
3	245	0.7938	194.481
4	475.2	0.7350	349.272
5	591.3	0.6806	402.439
			NPV = 1116.372

Payback Period is length of time needed to recoup an investment through the expected cash flows from the investment and is generally expressed in years. In other words, how long does it take for the intervention to pay for itself? The *simple payback period* is the smallest positive integer p such that

$$\sum_{t=0}^p A_{t,x} \geq 0$$

where $A_{t,x}$ represents the annual net cash flow of a program or intervention. The *simple payback period* does not consider the value of time; the cash flow entries are not discounted. The *discounted payback period* uses cash flow entries which have been discounted.

Using the cash flow example presented previously, the annual net cash flows have been derived and are shown in the top row of the table below (Table II-4). The payback period for this proposal occurs in year 2 because the sum of annual net cash flows for the project is <0 until year 2. Similarly, the payback period for maintaining status quo from an earlier table (Table II-1), is during the first year as the annual net cash flows are never <0 . Alternatively, the payback period can be calculated to reflect portions of a year. Using the following example, the payback period is 1.09 years.

Table II-4. Sample Payback Period Calculation.

For the year ending September 30	\$ in 1,000s						
	Year 0	Year 1	Year2	Year 3	Year 4	Year 5	Total
Net Cash Flow (CF)	(317.2)	295.5	248.2	245.0	475.2	591.3	1,537.9
Cumulative Net CF	(317.2)	(21.7)	226.5	417.5	946.7	1,537.9	

By inspection, the cumulative net cash flows are negative until sometime during year 2. Payback = 1.0 + (21.7 / 248.2) or 1.09.

Payback period is generally both simple to calculate and easy to understand. As a result, this merit measure is routinely used by companies and is sometimes used as a crude measure of risk. The alternative with the shorter payback period is considered less risky. Despite these attributes, the payback period remains a rough estimate and even if all the assumptions and data are precise, the exact payback day is rarely known. If the net cash flow is not positive through the time horizon, then the payback cannot be calculated. Any changes in cash flow (negative or positive) beyond the payback date are not accounted for in this merit measure.

Return on Investment is a widely used term with multiple definitions in the field of accounting. Examples of the various types of returns on investments include Return on Invested Capital, Return on Capital Employed, Return on Total Assets, and Return on Net Worth. Therefore, it is important that the methods for calculating the measure are clearly explained in the business case report. For the purposes of this effort, the *Simple ROI* is less of an accounting term than a generalized term for the expected value of an investment in terms of added revenue or profits, or averted expenses.

$$\text{Simple ROI} = (P_b - P_c) / P_c$$

where P_b represents the gains or benefits from the program or intervention and P_c represents the cost of that program or intervention. ROI can be presented as a ratio or as a percentage. As a ratio, it measures the effectiveness of the investment by calculating how many times the net benefits (benefits from investment minus initial and ongoing costs) recover the original investment. ROI is used to understand, evaluate and compare the value of different investment options. Although simple to define, identifying the costs and benefits necessary for calculation can be demanding. For example, an equipment redesign project is undertaken, at a cost of \$1.25 million. It is expected to be in place for at least 10 years. During that time it is expected to generate a savings of \$1 million in averted medical costs and lost productivity. Additional revenue streams from commercializing the technology are expected to produce \$3 million. The Simple ROI is (\$4 million-\$1.25 million) /\$1.25 = 2.2, which is generally expressed as a percentage, 220%, or ratio, 2.2:1.

Internal Rate of Return (IRR) is the discount rate at which the NPV is zero and is generally considered a simplified alternative to NPV. IRR takes into account the time value of money by considering the cash flows over the lifetime of a program or

intervention. However unlike the NPV, the Internal Rate of Return is an indirect measure of the value of the program or intervention, but nonetheless is a useful measure if a unique value exists. Mathematically, the is IRR represented as

$$\sum_{t=0}^n \frac{A_t}{(1+i)^t} = 0$$

where A represents the annual net discounted cash flow of program or intervention and i represents the interest rate. Notice that the IRR formula is merely the NPV formula set equal to zero, with cash flows known. Although the measure is conceptually simple, solving for the IRR can be more complex. Three basic methods are used to solve for the unknown interest value: trial and error, graphic representation, and financial calculator or computer solution.

Programs or interventions that have large cash outflow sometime during or at the end of its time horizon (as opposed to the normal case of one or more cash outflows followed by a series of cash inflows) can pose difficulties when employing the IRR as a merit measure. These type projects can have no solution, multiple solutions, or the solution can lead to an improper decision. To illustrate the latter assume two programs with the following cash flows (Table II-5).

Table II-5. Comparison of IRR and NPV as Merit Measures in a Large Cash Outflow Scenario.

Project	Expected Net Cash Flow		Merit Measure	
	Year 0	End of Year 1	IRR	NPV ($i=10\%$)
A	-\$100,000	\$120,000	20%	\$9,091
B	\$83,333	-100,000	20%	-\$7,576

Using the IRR as the merit measure and assuming a minimum attractive rate of return (MARR) or hurdle rate of 10%, both projects would be desirable. However, the NPV suggests that Project B may not constitute an acceptable funding opportunity.

Comparison of Merit Measures

Each merit measure has value and presents different information for consideration by the decision maker. The following example should make clear the differences in these merit measures. In this example, the analyst assesses two proposed options to a problem identified in the early stages of a business case. Each proposal has a cost of \$10,000, and the MARR for both is 12 percent. The net cash flows for each proposal are presented in Table II-6 below.

Table II-6. Assessing Proposed Options with Net Cash Flow Measures.

Year	Net Cash Flow	
	Proposal A	Proposal B
0	(10,000)	(10,000)
1	6,500	3,500
2	3,000	3,500
3	3,000	3,500
4	1,000	3,500

Table II-7 presents the cumulative cash flows for each proposal, which are necessary to calculate the payback periods.

In addition to helping decision makers select a final program or intervention, these results could also be used as a filter to reduce the number of viable proposals for the decision maker to consider. This example is simplistic in that both proposals have equal timelines and each merit measures suggest that Proposal A is the better selection. If there are proposals that are not mutually exclusive or have differing time lines, more complex analysis will be required. A full discussion of more complex computational situations or conditions is beyond the scope of this report, but can be readily found in financial management, project evaluation, or managerial accounting texts.

The “best” financial measure to be used when conducting a business case will depend on a number of factors. For example the analyst could calculate and present all measures or only the customary measure used by the organization or industry in the analysis. Alternatively, experts have stated that the accuracy of a merit measure depends on the timing and magnitude of the cash flows. Regardless, for the measure to lead to consistently accurate decisions, it must exhibit the following three properties:

- The method must consider all cash flows throughout the entire life of a project.
- The method must consider the time value of money; that is, it must reflect the fact that dollars which come in sooner are more valuable than distant dollars.
- When the method is used to select from a set of mutually exclusive projects, it must choose that project which maximizes the firm’s financial performance.

Table II-7. Assessing Proposed Options with Cumulative Cash Flow Measures.

Year	Cumulative Cash Flow	
	Proposal A	Proposal B
0	(10,000)	(10,000)
1	(3,500)	(6,500)
2	(500)	(3,000)
3	2,500	500
4	3,500	4,000

$$\text{Payback}_A = 2 + \$500/\$3000 = 2.17 \text{ years.}$$

$$\text{Payback}_B = 2 + \$3000/\$3500 = 2.86 \text{ years.}$$

$$\text{NPV}_A = -\$10,000 + \$6,500/(1.12)^1 + \$3,000/(1.12)^2 + \$3,000/(1.12)^3 + \$1,000/(1.12)^4 = 966.01$$

$$\text{NPV}_B = -\$10,000 + \$3,500/(1.12)^1 + \$3,500/(1.12)^2 + \$3,500/(1.12)^3 + \$3,500/(1.12)^4 = 630.72$$

$$\text{IRR}_A = 0 = -\$10,000 + \$6,500/(r)^1 + \$3,000/(r)^2 + \$3,000/(r)^3 + \$1,000/(r)^4 = 18.0\%$$

$$\text{IRR}_B = 0 = -\$10,000 + \$3,500/(r)^1 + \$3,500/(r)^2 + \$3,500/(r)^3 + \$3,500/(r)^4 = 15.0\%$$

$$\text{ROI}_A = \text{PV benefits-costs}/\text{PV costs} = \$966.01/\$10,000 = 9.7\%$$

$$\text{ROI}_B = \text{PV benefits-costs}/\text{PV costs} = \$630.72/\$10,000 = 6.3\%$$

As mentioned earlier, changes in cash flow beyond the payback date are not included in the calculations and therefore violate the first property. Undiscounted payback period violates the second property. However, many firms use this merit measure when the initial investment is small. The NPV, IRR, and ROI methods all satisfy the first and second properties. All three financial measures lead to identical and correct accept/reject decisions for independent projects. However, only the NPV method satisfies the third property under all conditions. If two programs or interventions are independent, NPV and IRR measures lead to the same conclusion. However, if both are mutually exclusive and not independent, the resulting measures may not lead to the same conclusions. Exclusive events are when if event *A* happens, then event *B* cannot, or vice-versa. Independent events are when the outcome of event *A* has no effect on the outcome of event *B*. So, if *A* and *B* are mutually exclusive, they *cannot* be independent. If *A* and *B* are independent, they *cannot* be mutually exclusive.

Conclusions

The evaluation process involves a study of the key factors that result from the IH action. Evaluation of an IH action includes strategic evaluation, economic evaluation, and financial impact evaluation. While the economic and financial evaluation of a project aims at determining the most efficient strategy for delivering the desired outcome, the strategic evaluation ensures that the project is consistent with the objectives of the organization. The financial appraisal may be the most important part of the evaluation

because the project cannot be successful if it is financially unviable, even though it may be otherwise feasible.

From this discussion of evaluation techniques and financial measures, a clear picture of the framework for the *Qualitative* and *Quantitative Approaches* developed.

The traditional strategy for capturing IH value has to be broadened. Traditional S&H strategies and approaches focus on cost. That is not without reason; other disciplines also look to cost when measuring value. Phil Crosby, a well respected thought-leader in the quality movement defined the cost of quality as the “cost of conformance” (i.e., the cost of a company’s quality assurance program) plus the “cost of nonconformance” (the cost of quality defects). The IH corollary is that the cost of industrial hygiene is the cost of IH related loss plus the cost of IH programs and activities. *Gross cost savings* from IH programs or activities would be the cost of IH-related loss before the program or activity minus the cost of IH-related loss after the IH program or activity. *Net cost savings* would be gross IH-related cost savings minus the cost of the IH program or activity.

This formula still works. However, in addition to tracking cost savings and cost avoidance, two new categories need to be added to the framework for capturing value. First, there are situations where IH programs and activities result in **new revenue** for the business. So a mechanism is needed to capture revenue generation. Second, a means for capturing key impacts on the business process is needed.

In short, the cost-based approach that has been used in S&H and other disciplines should be expanded to a new framework as follows:

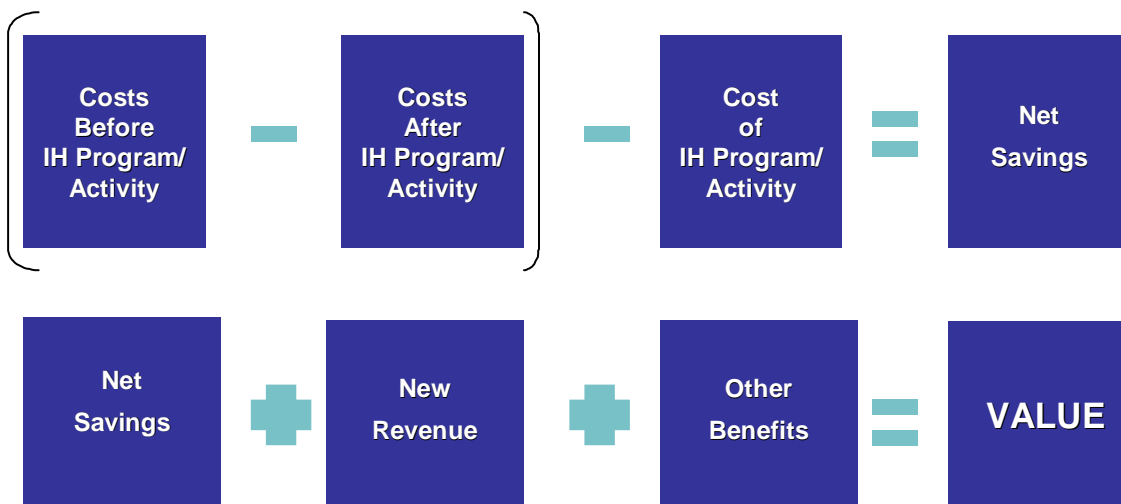


Figure II-1. New Framework for Cost-based Valuation.

Review of Relevant Existing Models and Approaches

Full Models

Generic systems or full models (models, data collection instruments, and instructional documentation) to capture the benefits to an enterprise of implementing occupational safety and health interventions are limited in number. The following examples are the most widely used models or methods found in the literature. The elements used in these

models provide candidate key program elements for inclusion in a strategy to fully derive the value of the IH profession.

Model A: The Productivity Assessment Tool

One of the earliest specific models, the Productivity Assessment Tool, is an economic analysis tool designed to show that productivity and profit for an enterprise are compatible with safe and healthful working conditions for its employees. This tool, developed by Maurice Oxenburg, provides a framework to calculate the costs and benefits of occupational safety and health interventions. This computerized strategy emphasizes the costs and benefits that the employees bring to the organization. More specifically, the tool evaluates the potential costs and benefits of specific changes in working conditions by exploring the changes in the employee productivity. By far, ergonomic interventions have constituted the largest share of the analyses using the Productivity Assessment Tool.

Oxenburg has provided detailed instructions and explanations for the following four parts of the tool:

Table II-8. The Four Parts of the Productivity Assessment Tool.

	Initial Case Enter data on:	Test Case(s) Enter expected changes for:
Data concerning the employees	productive hours wage costs overtime reduced productivity	productive hours wage costs overtime reduced productivity
Data concerning the workplace	Recruitment insurance reduction in waste energy use other overheads	recruitment insurance reduction in waste energy use other overheads
The intervention	costs, or estimated costs, for the intervention	
The reports	Cost-benefit analysis calculations and reports of the workplace and the employees	

Source: Oxenburg, Marlow and Oxenburgh, 2004, Figure 4.1

This model measures productivity changes against what is termed the “ideal state.” Simply put, this is the production level if all resources were operating at full capacity. The model captures the annual hours paid by the employer, minus the hours that the employee is not actively producing. Losses of productive time include absences from injury, illness, training, vacation and holidays, or other absences such as maternity or military service leave. The hours of productive time are multiplied by the wage of the worker. This is not an individual wage for each employee, but rather an average for an employee category or occupation. The most robust of the available programs will allow up to five employee categories to be considered. Any additional wages, such as overtime, are added to finalize the annual productive value.

The program offers a series of screens to capture the necessary data for calculations. Data concerning the employee uses three screens with sections for the initial and test

cases. The first screen in this series asks for data on the number of employees, hours per week, and the absences associated with the individual employee or employee group.

Employer costs, administrative, managerial, and supervisory costs, are captured in the next screen. Employee supervisory costs include first line, middle, and senior level management. Administrative costs include the following categories:

- Administrative costs
- Pension fund
- Workers' compensation premiums
- Taxes on wages paid by the employer
- Personnel/human resources department
- Medical and direct injury costs
- Head office allocation.

The final screen for capturing employee data requests a percentage of reduced productivity. This information is also used to identify the need for intervening or modifying the working conditions for the group of employees being examined. The following table is the overview of that data screen.

Table II-9. The Productivity Assessment Tool: Potential Interventions for Reduced Productivity.

Reason for reduced productivity	Typical interventions that would lead from these factors
Low skill	Improve or increase training
Hand tools	Replace or improve hand tools with a design better suited to the work tasks
Capital	Improve maintenance, replace machinery.
Other	Factors not covered above
Reduced productivity (%) and cost per year for the year for the employee group based on employee costs	

Source: Oxenburg, Marlow and Oxenburgh, 2004, Figure 4.4

Capturing workplace data is completed through two screens. The first collects information on allocated costs. This section considers overhead costs that should be proportioned to the employee group being analyzed. This can include workers' compensation premiums, organizational administrative functions, equipment running costs, and maintenance costs. Warning is provided not to double count the costs already entered under the employee data. The second screen captures recruitment costs, which are associated with hiring new employees and the skill loss when employees leave.

Intervention costs are entered in the allocated costs screens under the test case column and include capital costs, management, and consultant time and costs. The effects of the intervention are entered on the remaining screens as appropriate. Following these entries, three report screens are generated: Workplace Summary, Employee Summary, and Workplace Report.

In summary, this model presents estimated productivity changes and health effects of a proposed action and produces savings per year and payback periods for use in creating other financial metrics.

Model B: The Net Cost Strategy

In 2005, Lahiri et al. published an accounting framework to derive the net costs for employers of implementing workplace interventions. Although the strategy can be applied to multiple interventions, the initial application of the strategy was focused on low back pain interventions. They defined net costs as the “investment cost for intervention equipment plus labor costs involved in implementing the intervention minus avoidable health care costs of illness and injury, productivity losses due to loss in efficiency and absenteeism, and other benefits related to productivity enhancement of all workers subjected to the intervention.” This research team developed both a graphical and mathematical model to demonstrate the worth of an occupational safety and health intervention. Figure II-2 below presents the graphical Net-Cost model.

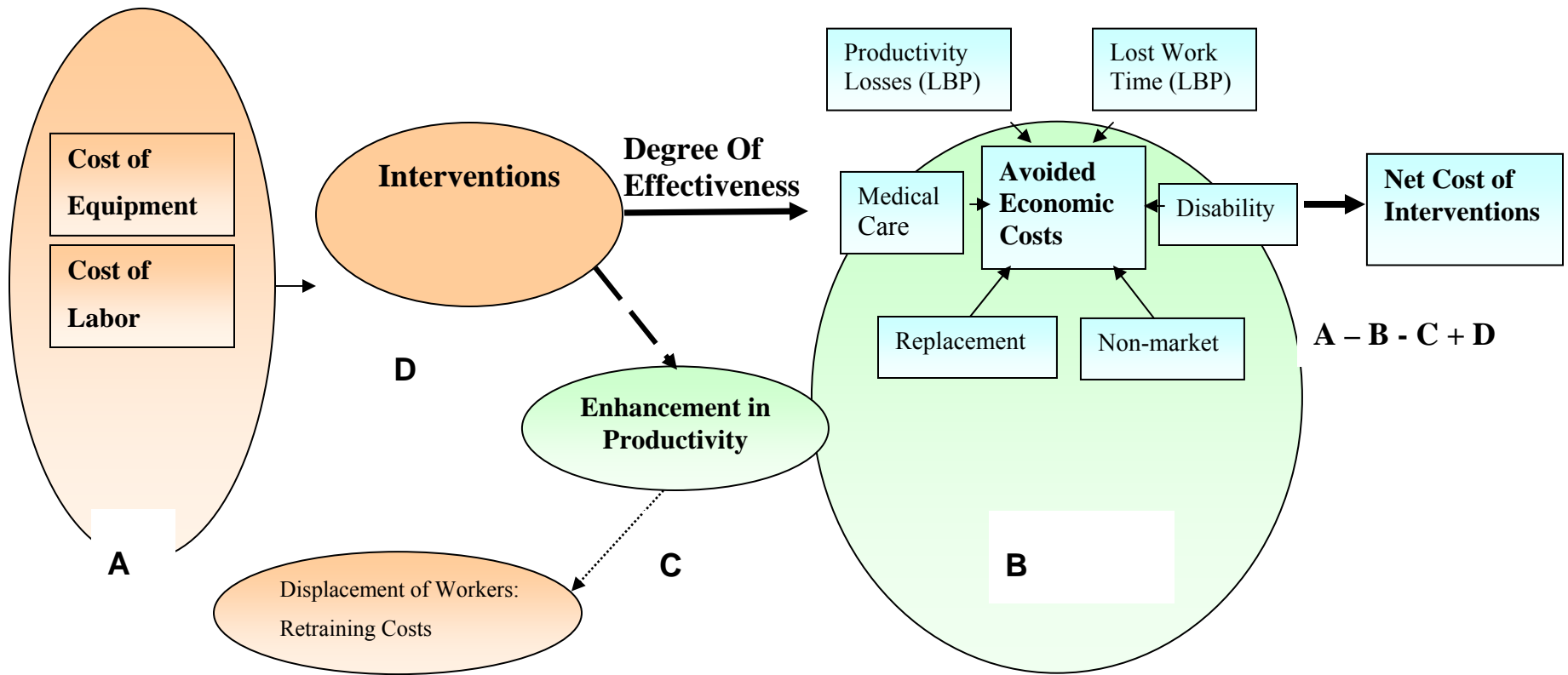


Figure II-2. A Strategy Overview: Annualized Net Cost of Interventions for Preventing Occupational Low Back Pain (LBP)

The following excerpt (Lahiri, 2005), including explanatory footnotes, presents the specific elements and their definitions which are included in the Net-Cost Model:

Annualized Net Economic Costs Of Safety Interventions For Preventing Occupational Low Back Pain (LBP) = Annualized Additional Direct Investment Costs On Equipment For Interventions + Annual Labor Costs For Implementing The Intervention - Avoided Annual Economic Costs Of LBP - Annual Value Of Increase In Productivity For All Workers Subjected To The Intervention

Avoided Annual Economic Costs Of LBP = Avoided Medical Care Costs + Avoided Reduction In The Value Of Lost Work Time Due To LBP Sick Leave + Avoided Reduction In Productivity Losses Due To LBP When Not On Sick Leave

Annualized Net Economic Costs Of Safety Interventions For Preventing Occupational LBP Per Worker = Annualized Net Economic Costs Of Safety Interventions / (Total Workforce In The Organization)

Direct Costs on Equipment

Total Additional Direct Investment Cost Of Each Equipment = Total Direct Current Costs Of Investments In Each New Equipment After Intervention - Total Direct Costs Of Investments In Each Similar Type Of Equipment Prior To Intervention ¹

Total Direct Current Costs Of Investments In Each New Equipment = Price Of Each New Equipment In 2002 Dollars * Quantity Of Each New Equipment

Total Direct Prior Costs Of Investments In Each Similar Type Of Equipment = Price Of Each Prior Equipment In 2002 Dollars * Quantity Of Each Equipment Prior To Intervention

Capital Recovery Factor For Each Equipment = Market Rate Of Interest + Rate Of Depreciation For Each Equipment ²

Annualized Additional Direct Investment Cost Of Each Equipment = Capital Recovery Factor Of Each Equipment * Total Additional Direct Investment Cost Of Each Equipment

Total Annualized Additional Direct Investment Cost Of All Equipment = Sum Of Annualized Additional Direct Investment Cost Of All Equipments Used the Interventions

¹ For example, we should take the price of an ergonomically approved adjustable chair and deduct from that the price of a traditional chair that was used originally. It is this additional cost of an adjustable chair that should be treated as equipment cost.

² The depreciation for each type of equipment has been calculated by taking into account the life of the equipment and their salvage value by using the depreciation formula explained in the text.

Annualized Additional Direct Costs Of Interventions = Total Annualized Additional Direct Investment Cost Of All Equipment + Annual Labor Costs For Intervention Implementation³
Avoided Medical Care Costs

Total Annual Avoided Medical Care Costs = [Medical Care Costs Before Intervention (Acute Cases) - Medical Care Costs After Intervention (Acute Cases)] + [Medical Care Costs Before Intervention (Chronic Cases) - Medical Care Costs After Intervention (Chronic Cases)]

Medical Care Costs Before Intervention (Acute) = Average Medical Care Cost Per Acute Case In 2002 Dollars * Number Of Employees Suffering From Acute LBP Before Intervention⁴

Medical Care Costs Before Intervention (Chronic) = Average Medical Care Cost Per Chronic Case In 2002 Dollars * Number Of Employees Suffering From Chronic LBP Before Intervention

Medical Care Costs After Intervention (Acute) = Medical Care Cost Per Case In 2002 Dollars * Number Of Employees Suffering From Acute LBP After Intervention

Medical Care Costs After Intervention (Chronic) = Medical Care Cost Per Case In 2002 * Number Of Employees Suffering From Chronic LBP After Intervention

Loss In Productivity Due To LBP

Avoided Productivity Losses Due To LBP = Reduction In The Value Of Lost Work Time Due To LBP + Reduction In Efficiency Due To LBP When Not On Leave

Reduction In The Value Of Lost Work Time Due To LBP = Value Of Lost Work Time Due To Sick Leave Before Intervention - Value Of Lost Work Time Due To Sick Leave After Intervention

Value Of Lost Work Time Due To Sick Leave Before Intervention = Number Of Missed Days Of Work Before Intervention * Wage Per Hour In \$ Paid During Sick Leave Due To Back Pain * Number Of Work Hours Per Day

Value Of Lost Work Time Due To Sick Leave After Intervention = Average Number Of Missed Days Of Work After Intervention * Wage Per Hour In \$ Paid During Sick Leave Due To Back Pain * Number Of Work Hours Per Day

Reduction In Efficiency Due To LBP When Not On Leave = Total Number Of Employees Suffering From LBP Without Leave * Number Of Days Of Duration Of LBP For Each Employee * Coefficient Of Loss In Productivity

Coefficient Of Loss In Productivity In Dollars = Average Wage Rate – Adjusted Average Wage Rate Taking Into Account The Percentage Loss In Productivity

³ For example this cost included all costs involved in training workers to use ergonomically designed equipments.

⁴ Medical care cost per case in 2002 dollars obtained from Spine Vol. (median value)

Enhancement In Productivity

Annual Value Of Increase In Productivity Due To The Intervention = Number Of Workers Subjected To Intervention * Number Of Work Hours Per Week * Number Of Weeks Worked Per Year * Coefficient Of Productivity Gain Due To The Intervention

Coefficient Of Gain In Productivity In Dollars = Adjusted Average Wage Rate Taking Into Account The Percentage Gain In Productivity - Average Wage Rate

This complex model includes two general elements: the impact on changes in health and productivity. Despite the complexity of the model, the elements critical to normative evaluations that demonstrate qualitative benefits have not been included. Furthermore, there is no method of determining the effectiveness of the intervention in reducing or eliminating the identified hazard or risk.

Model C: CERSSO Tool Kit

The Regional Center for Occupational Safety and Health (CERSSO) developed the Tool Kit as an “instrument designed for you to test it within the confidentiality of your business and which through a simple manner can help show you how much money you are losing by not investing in the Safety and Health of your employees” (Biddle, 2004). This six-step model begins with defining the magnitude of the problem and ends with an analysis of the costs and benefits of an occupational safety and health investment. The following table presents a summary of the steps to complete the CERSSO strategy entitled “Self Evaluation of the Cost-Benefit on the Investments in Occupational Safety and Health in the Textile Factory.”

Table II-10. The Six Steps of the CERSSO Strategy.

PARTS	MEASURES
1 Definition of the Magnitude of the Problem according to causes and effects	1.1.a. Description of Operations
	Prioritizing the causes (risks and demands)
	Description of the male and female employees in their operations
	Description of the CAUSES (risks and demands) by their Operations.
	Description of EFFECTS and their relationship with the causes
2 Risk Appraisal	Appraisal of the probability of the effect
	2.2 Appraisal of the severity of the effect
	2.3. Appraisal of the risk
3 Definition of the preventive measures to be undertaken.	Definition of the preventive measures to be undertaken.

PARTS	MEASURES
4 Graphing the relationship between the preventive measures and their positive impact.	Graphing the relationship between the preventive measures and their positive impact.
5 Evaluating the cost of prevention and its effects	Identifying the costs of the preventive measures made at the source, individuals and preventive medical actions.
	Identifying the direct costs caused by the potential effects.
	Identifying the indirect costs caused by the potential effects.
	Totaling the costs.
6 Analysis of the Costs - Benefits	Compare and contrast the costs of the measures taken and the costs of the potential effects.

This strategy presents a more complete picture of the safety and health process by identifying and evaluating the working conditions and risk factors followed by a risk appraisal. The strategy provides the following list of risk categories (a-d) and demands categories (e-h) for reference:

- a. Work environment:
 - Physical: Noise, vibrations, heat, humidity, radiation, light
- b. Work objects:
 - Organic or inorganic dust
 - Synthetic chemical substances
 - Live biological (plants, microorganisms, rodents, insects) or derivatives (animals, vegetables)
- c. Risks the work environments present by themselves:
 - Tools
 - Machines
 - Work center facilities
- d. Risks derived from the environmental conditions:
 - Natural environment
- e. Physical, static and postural loads
- f. Uncomfortable and/or forced positions

g. Dynamic physical activity:

Physical exertion
Movement
Repetitive movements

h. Organization and division of work:

Long shifts
Remuneration system: by time, by work done
Type of job agreement
Work content

The risk appraisal determines the probability, consequences, and severity of the health effect. The model also employs the Johansen and Johren “Ball Model” to graph the impact of the intervention.

The evaluation of the effects of the prevention effort are determined by assigning costs to the specific interventions, which can be implemented at the source of the hazard, for use by the worker, or as medical measures. The prevention effort can include multiple interventions or what is more commonly thought of as a program. Although the link between risk and the effect of the intervention is discussed, there is no accompanying discussion of the value of the risk reduction. Table II-11 illustrates the method for calculation of prevention effort costs.

The model next provides a procedure to estimate the “costs caused by the effects” by looking at direct and indirect cost categories. These categories capture the costs associated with an incident and represent avoided costs that result from implementing the prevention efforts. The direct costs consist primarily of medical expenses and the indirect costs are associated with lost productivity. The forms and examples did not provide a mechanism to capture any additional benefits resulting from the prevention activity. However, it is worth noting that the model documentation presented the following list of benefits that follow implementing an occupational safety and health program.

For employers:

- Reduction of operating costs
- Increase of productivity levels
- Creation of a great public image
- Satisfaction in the deliveries
- Development of a niche in the market with recurrent clients
- Reduction of incident costs
- Reduction of absences due to illnesses

Table II-11. Method for Calculating Prevention Effort Costs.

Intervention Carried Out	Cost Unit for Estimate	Measurement Unit	Number of Units per Operation	Units' Requirements	Monthly Unit Cost in US \$	Estimate of Total Monthly Costs Per operation
A	B	C	D	E	F	G
AT THE SOURCE						
Lighting System Maintenance	Technical or Professional	Lamps	Number of Lamps	Maintenance every six months	(0.50 each lamp)/6 months	D * F
FOR INDIVIDUAL WORKERS						
Ocular Protectors when applying laser (to block radiation)	Eyeglasses	Eyeglasses	Number of Workers	Change every 6 months	3.62 /6 months	D * F
MEDICAL MEASURES						
Pre-Employment Test	Professional	Consultation	Number of Workers	A Consultation	30.00 / 6 months	D * F
	Worker	Hours/resources Normal Hourly production	Number of Workers	An hour	(Salary of each workers) + (cost of drop in the normal hourly production of each worker)/ 12 months	D * F
TOTAL						

For employees:

- Increased motivation at work, which causes a feeling of safety which is in turn reflected by a greater productivity
- Real possibilities of improving to their income.

Model D: Return on Health, Safety and Environmental Investments (ROHSEI)

Fifteen member companies of the ORC Occupational Safety and Health Group—ALCOA, Allied Signal, ARCO, Bayer, Bristol-Myers Squibb, Colgate-Palmolive, Dow, Duke Power, Eli Lilly, IBM, Johnson & Johnson, Monsanto, M&M Mars, Rhone-

Poulenc Rorer, and Schering-Plough—formed a task force to work with ORC Worldwide and Arthur Andersen to tailor traditional financial investment analysis approaches and apply them to achieve a better understanding of the business impacts of health, safety and environmental investments.

The *Return on Health, Safety and Environmental Investments* (ROHSEI) process and tools were developed through interviews with financial, safety and health, and operational professionals; data collected from more than a dozen companies; focus group sessions; and field testing. Since 1997, ROHSEI has demonstrated that analytical tools currently used and accepted by the financial community can be applied to safety and health investments when appropriate data elements underpin the analysis. The process allows users to evaluate safety and health investments on a cost/performance basis. Building the business case employs the following four steps:

1. Understand the opportunity or challenge
2. Identify and explore alternative solutions
3. Gather data and conduct analysis
4. Make a recommendation.

The following figure highlights the relationship among these four steps and the business case development. It also introduces four tools to support the process: a *Business Case Summary*, a *Causal Loop Diagram*, a *Direct Impact Module*, and a *Decision Matrix*.

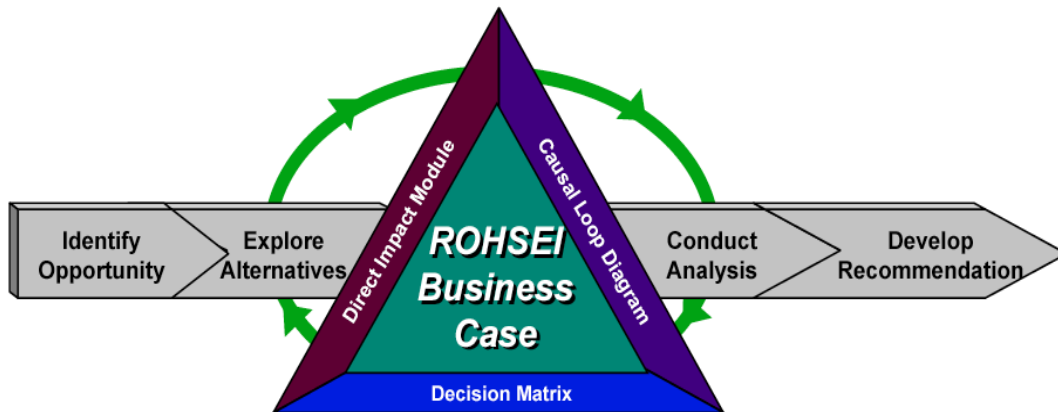
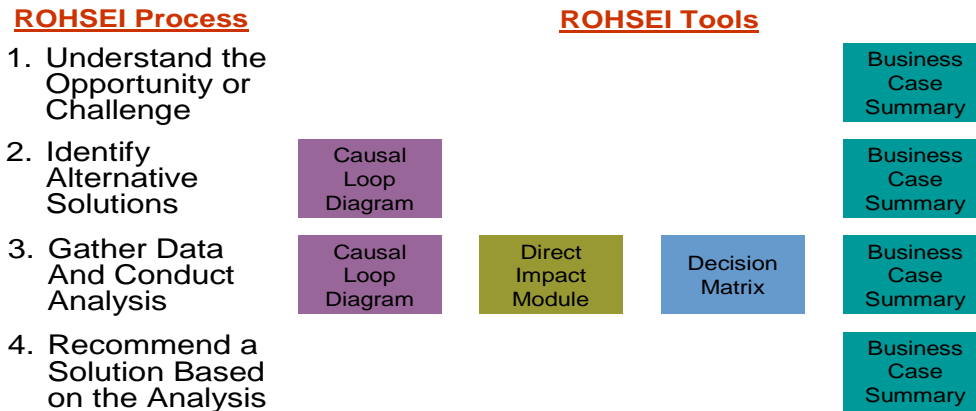


Figure II-3. The ROHSEI Process and Tools.

The following Table demonstrates how the tools are aligned with the process steps. For example, the *Causal Loop Diagram* is a tool designed to brainstorm alternative solutions, explore relationships, and identify other impacts of the project. It helps develop a comprehensive view of how each of the alternative investments impacts business performance, considering both direct and hidden benefits and costs.

Table II-12. The Alignment of ROHSEI Processes and Tools.



For each alternative, the ROHSEI process facilitates consideration of direct benefits and costs as well as hidden impacts, such as worker productivity. The following is a comprehensive list of the parameters and their definitions that are embedded in the program.

Operational Personnel Time

For program costs and benefits, consider the cost of operational personnel time spent on:

- Safety and Health (S&H) program activities including maintenance, meetings, housekeeping, recordkeeping, and program implementation
- S&H training
- Conducting strategic analysis and planning driven by S&H issues. Examples of this include developing S&H objectives and performance measures, evaluating S&H concerns for capital purchases, and managing S&H issues.
- Reviewing and modifying production methods or product designs to incorporate S&H concerns
- Performing required or voluntary S&H inspections and audits such as compliance activities, audits, reporting, monitoring and testing, emergency response training, and drills.
- Monitoring S&H performance.

For incident costs, consider the cost of operational personnel time spent on:

- Reporting and investigating incidents, creating alternative solutions, and implementing solutions such as making process or equipment changes
- Coordinating with S&H professionals
- Working as replacements for injured workers (e.g., overtime)
- Responding to emergencies.
- Additional monitoring and testing of employees' health and safety associated with incidents.

Safety and Health Personnel Time

For project costs and benefits, consider the cost of S&H personnel time spent on:

Developing and implementing S&H programs and processes including auditing programs, S&H-related housekeeping, recordkeeping, an emergency response plan, and S&H reporting.

S&H training.

Conducting strategic analysis and planning driven by S&H issues, such as developing S&H objectives and performance measures, evaluating S&H concerns for capital purchases, and managing S&H issues. Also would include time spent communicating safety performance programs with regulators and community.

Reviewing and modifying production methods or product designs to incorporate S&H concerns.

Monitoring S&H performance.

Performing required and voluntary S&H inspections and audits, such as compliance activities, audits, reporting, monitoring and testing, emergency response training, and drills.

Monitoring and testing the health and safety of employees (include only S&H employees' time here; operational personnel time should be included in Operational Personnel Time). This includes the cost of S&H personnel time relating to air sampling activities and related laboratory analyses, noise monitoring, medical screenings, and worker physical examinations, etc. The cost of the equipment required is not included here, but rather in S&H Equipment.

For incident cost, consider cost of S&H personnel time spent on:

Reporting and investigating incidents, creating alternative solutions, and implementing solutions.

Responding to emergencies.

Additional monitoring and testing of employees' safety and health associated with incidents.

Design and Engineering Personnel Time

For program costs and benefits, consider:

The time that design and engineering personnel dedicate to safety and health-related functions.

Other Personnel Time

Customize this parameter to the analysis. If, for example, the project will either require or obviate significant management resources, consider defining the parameter as "Management Personnel Time." See the definitions for Safety and Health Personnel Time, Operational Personnel Time, and Design and Engineering Personnel Time as guidance in writing the definition.

Vendors, Consultants and Contract Labor

For program costs and benefits, consider the cost of vendors, consultants, and contract labor spent on:

Conducting ongoing S&H activities (e.g. training, strategy development, etc.), S&H inspection and audits, employee S&H monitoring and testing, and ensuring compliance.

For incident costs, consider the cost of vendors, consultants, and contract labor spent on:

Tasks associated with H&S incidents, including incident investigations. Tasks required in the process of replacing injured employees. This includes the cost of using a third party to train replacement labor (contracted and internal) required to replace employees impacted by a S&H incident.

Health and Safety Supplies

This parameter should include only expense items. Any S&H supplies that will be capitalized should be included in the Capital parameter.

* H&S supply purchases such as Personal Protection Equipment (PPE).

Operations and Maintenance

For project costs and benefits, consider operating and maintenance cost related to S&H, including:

Maintenance supplies (do not double count with the S&H Supplies parameter)
Utility costs of running S&H-related equipment (e.g., ventilation equipment, monitors) and operations equipment associated with S&H-related projects.
Ongoing preventative maintenance done for S&H purposes—beyond that which is done to optimize production processes. This should not include personnel time already captured in other parameters.

For incident cost, consider:

Additional equipment maintenance or repair due to an S&H incident
Cost of repairing equipment after an S&H-related problem or failure.

Production Downtime

The ROHSEI strategy provides flexibility with regard to use of the Production Downtime parameter.

Method 1. This parameter can be used to capture all costs associated with Production Downtime which may include overtime, replacement labor, equipment repair, lost material, lost profits, the cost of purchasing capacity to meet customer demands, as well as other relevant items.

Method 2. Alternatively, this parameter can be used to capture only those types of costs that cannot reasonably be captured in other parameters. In other words, overtime associated with Production Downtime would be captured in the appropriate Personnel Time parameters and external replacement labor would be included in the Vendors, Consultants, and Contractor Labor parameter. With

Method 2, The Production Downtime parameter may include lost material, lost profits, the cost of purchasing capacity to meet customer demands, as well as other relevant items.

The activities included as Production Downtime depend upon which method you pursue. In either case, you may use the builds the strategy provides for you by clicking on the "Go to Build" button.

For program cost and benefits, consider:

Net loss of revenues (after accounting for averted costs) or loss of raw materials from scheduled production downtime to perform preventive maintenance on equipment due to S&H concerns.

For incident costs, consider:

Net loss of revenues (after accounting for averted costs) or loss of raw materials from unscheduled production downtime due to an S&H incident.

Business Interruption Insurance

For program benefits, consider:

If a S&H program is expected to decrease the cost of business interruption insurance premiums, the expected cost savings should be entered as program benefit. Premium reductions may be due to reduced risk of having incidents or reduced expected severity of incidents. The rationale for this parameter should be documented in the "Scenario Assumptions" worksheet.

For program costs, consider:

If a S&H program is expected to increase the cost of business interruption insurance premiums, the expected additional cost should be entered as a program cost. The rationale for this parameter should be documented in the "Scenario Assumptions" worksheet.

For incident costs, consider:

The increased cost of business interruption insurance premiums due to S&H incidents.

Legal Fees, Workers Comp & Settlements

For program benefits, consider:

If an S&H program is expected to decrease legal fees, claims management processing, and worker's compensation costs (including legal settlements) paid out due to S&H claims, the expected cost savings should be entered as program benefit.

For program costs, consider:

If a S&H program is expected to increase legal fees, claims management processing, and/or workers' compensation costs (including legal settlements) paid out due to S&H claims, the expected cost increase should be entered as program cost.

For incident costs, consider:

Internal and external fees related to S&H incidents. This would also include the cost of maintaining claims management processors.
Cost of workers' compensation (including legal settlements) paid out due to H&S claims.

Medical Costs and Insurance

For project costs and benefits, consider the cost of:

Insurance premiums or set-asides for insuring against injuries and fatalities.
Medical staff and facilities to perform medical screenings and other employee H&S monitoring and testing. This should not include S&H or operations personnel time.

For incident costs, consider:

Premium increases and medical costs related to incidents.

Property Damage Insurance

For program benefits, consider:

If a S&H program is expected to decrease the cost of property damage insurance premiums the expected cost savings should be entered as program benefit. Premium reductions may be due to reduced risk of having incidents or reduced expected severity of incidents. The rationale for this parameter should be documented in the "Scenario Assumptions" worksheet.

For program costs, consider:

If an H&S program is expected to increase the cost of property damage insurance premiums, the expected additional cost should be entered as a program cost. The rationale for this parameter should be documented in the "Scenario Assumptions" worksheet.

For incident costs, consider:

The cost of property damage insurance premiums due to H&S incidents.

Loss of Raw Materials, Product

For incident costs, consider:

The cost of reproducing product and repurchasing materials that were wasted due to an S&H incident.

Fines and Penalties

For program benefits, consider:

If a S&H program is expected to decrease fines and penalties, the resulting cost savings should be entered as program benefit.

For program costs, consider:

If an H&S program is expected to increase fines and penalties, the resulting additional cost should be entered as program cost.

For incident costs, consider:

The amount of fines and penalties paid to regulators as a result of S&H incidents and non-compliance events.

Emergency Response

Any capitalized equipment costs for emergency response should be included in the Capital parameter and not in the Emergency Response parameter. The ROHSEI strategy provides flexibility with regard to use of the Emergency Response parameter.

Method 1. This parameter can be used to capture all costs associated with Emergency Response--except capitalized items--which may include dedicated personnel, vendor expenses, and supplies.

Method 2. Alternatively, this parameter can be used to capture only those types of costs that cannot reasonably be captured in other parameters such as Vendors, Consultants, and Contractor Labor and S&H Supplies, and Operations & Maintenance.

The activities that Emergency Response should include depend upon the method pursued. In either case, the builds the strategy provides may be used by clicking on the "Go to Build" button when data are entered using the incident approach.

For project costs and benefits, consider:

Maintaining emergency response resources and emergency response equipment and supplies.
Cost of inspecting and repairing emergency response equipment.

For incident costs, consider:

Using emergency response equipment (don't double count these costs with those in the personnel time parameters).
Emergency response staff time. If operations and S&H personnel costs are included here, don't double count these costs with those in the personnel time parameters.
Using vendors, consultants, and contracted labor for emergency response can be entered here, but don't double count with Vendor, Consultants, and Contract Labor parameter.

Material Recovery

For program benefits, consider:

If a S&H program leads to an increase in material recovery, the resulting cost savings should be entered as program benefit.

For program costs, consider:

If a S&H program leads to a decrease in material recovery, the resulting additional cost should be entered as a program cost.

Material Substitution

For program benefits, consider:

If an S&H program leads to material substitution, the cost of the material being substituted should be entered as a program benefit. Include the expected change in the material's price over time.

For program costs, consider:

The cost of the new material should be entered as a program cost. Include the expected change in the material's price over time.

Waste Disposal

For program benefits, consider:

If an S&H program leads to a reduction in waste disposal expenses when compared to the current situation, the resulting cost savings should be entered as program benefit.

For program costs, consider:

If an S&H program leads to an increase in waste disposal expenses when compared to the current situation, the resulting additional cost should be entered as a program cost.

Water Treatment

For program benefits, consider:

If an S&H program leads to a reduction in water treatment expenses when compared to the current situation, the resulting cost savings should be entered as a program benefit.

For program costs, consider:

If an S&H program leads to an increase in water treatment expenses when compared to the current situation, the resulting additional cost should be entered as a program cost.

The depreciation worksheet for capital investments associated with water treatment equipment should be used, so that the tax implications may be calculated properly.

Remediation Project Spending

For program benefits, consider:

If an S&H program leads to a reduction in remediation expenses when compared to the current situation, the resulting cost savings should be entered as program benefit.

For program costs, consider:

If an H&S program leads to an increased remediation expenses compared to the current situation, the resulting additional cost should be entered as a program cost.

Emissions Controls

For program benefits, consider:

If a S&H program leads to a reduction in emissions control expenses when compared to the current situation, the resulting cost savings should be entered as program benefit.

For program costs, consider:

If a S&H program leads to an increase in emissions control expenses when compared to the current situation, the resulting additional cost should be entered as a program cost.

The organization's financial professionals should be consulted regarding proper treatment (expense vs. capitalize) of emissions control equipment.

Energy

For program benefits, consider:

If a S&H program leads to a decrease in energy consumption or rates, the resulting cost savings should be entered as program benefit.

For program costs, consider:

If an S&H program leads to an increase in energy consumption or rates, the resulting additional cost should be entered as a program cost.

Using the ROHSEI strategy as prescribed, sufficient data will be collected to determine the following financial measures:

- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Return on Investment (ROI)
- Discounted Payback (DPP)
- Production Equivalent Units
- Impact on Unit Cost
- Percent Impact on Unit Cost.

Conclusions

Only a limited number of value models have been used in the occupational safety and health field. The models presented here were selected because of their availability and transparency of the derivation of value. Each strategy included measures of the cost of occupational injury or illness and some measure of productivity loss. The extent to which they capture benefits, tangible and intangible, varies substantially in both quantitative and qualitative measures. Finally, while the models may have presented the hazard and a risk measure, they did not include a measure of the reduction of the risk in the workplace.

Literature Review

In addition to examining the full models presented in the previous section, it is also important to examine individual evaluation studies. Published individual studies of the economic or financial effectiveness of occupational safety and health interventions are few in number. In 2007, Emile Tompa from the Institute of Work & Health published a systematic review of such interventions that included an economic analysis. There were nearly 13,000 intervention evaluations published that met the initial criteria for inclusion. However, only 72 were evaluated in depth as it was determined that only these could answer their research question “What is the credible evidence that incremental investment in health and safety is worth undertaking?” The interventions spanned multiple industry sectors and included six kinds of interventions. These six included programs designed for:

- Ergonomic and other musculoskeletal disorder (MSD)
- Occupational disease
- Disability management
- Multiple interventions
- Health promotion
- Violence in the workplace.

Ergonomic and other MSD interventions were the most commonly evaluated among these studies. The following tables provide information on evaluations focusing on categories under the auspices of the industrial hygienist functions.

Table II-13. Literature Review Results: Monetary Consequences and Costs of S&H Interventions.

Study Reference	Monetary Consequences			Monetary Costs			
	Productivity Changes	Insurance & Health-Care Savings	Other	Capital Equipment Expenditures	External Services	Internal Staff Time	Other
Amick (2003); DeRango (2003)	Yes	~	~	Yes	Yes	Yes	~
Lahiri (2005)	Yes	Yes	~	Yes	Yes	Yes	~
Rempel (2006)	~	Yes	~	Yes	~	~	~
Bradley (1996)	~	Yes	~	Yes	~	Yes	~
Kemmlert (1996)	Yes	Yes	Yes	Yes	~	Yes	~
Tadano (1990)	~	~	Yes	~	Yes	~	~
Wahl (1998)	~	Yes	~	~	~	Yes	~
Lewis (2002)	~	Yes	~	~	~	~	~
Landstad (2002)	Yes	~	~	~	~	~	Yes
Landers (2004)	~	~	Yes	~	~	~	Yes
Feuerstein	Yes	~	Yes	~	~	~	~

(2000)							
Laufer (1994)	Yes	~	Yes	~	~	~	Yes
Yassi (1995)	Yes	~	Yes	~	Yes	~	Yes
Orenstein (1995)	~	~	~	~	Yes	Yes	Yes
Korniewicz (2005)	~	Yes	~	~	~	Yes	~
Cameron (1997)	~	~	~	Yes	~	Yes	Yes
Collins (2004)	~	Yes	~	Yes	~	Yes	~
Chhokar (2005)	~	Yes	~	Yes	~	~	~
Gundewall (1993)	Yes	~	~	~	~	Yes	~
Evanoff (1999)	~	Yes	~	Yes	~	Yes	~
Engst (2005)	~	Yes	Yes	Yes	~	Yes	~
Li (2004)	~	Yes	~	~	~	~	~
Ore (2003)	~	Yes	~	~	~	Yes	~
Brophy (2001)	Yes	Yes	~	Yes	~	~	~
Kemmlert (1996)	Yes	Yes	Yes	Yes	~	Yes	Yes
Charney (1991)	~	Yes	~	~	~	Yes	~
Guthrie (2004)	Yes	~	~	~	~	~	~
Linton (1992)	Yes	~	~	~	Yes	~	Yes
Yassi (1995)	~	Yes	~	~	~	~	~
Bernacki (2003)	~	Yes	~	~	~	~	~
Koviack (2004)	Yes	~	~	~	~	~	~
Tracz (1992)	Yes	~	~	~	~	~	~
Davis (2004)	~	Yes	~	~	~	~	~
Collins (1990)	~	Yes	~	~	~	~	~
Caulfield (1996)	~	Yes	~	~	~	~	~
Martin (1995)	~	Yes	~	~	~	~	~
Hocking (1991)	Yes	Yes	~	Yes	~	Yes	~
Lanoie (1996)	Yes	Yes	~	Yes	~	Yes	Yes
Lahiri (2005)	Yes	Yes	~	Yes	Yes	Yes	~
Lahiri (2005)							
Abrahamsson (2000)	Yes	~	~	Yes	Yes	~	~
Halpern (1997)	~	Yes	~	~	~	~	~
Kemmlert (1996)	Yes	Yes	Yes	Yes	~	Yes	~
Kemmlert (1996)							

Moore (1998)	~	Yes	~	~	~	~	~
Ridyard (2000)	~	Yes	Yes	~	~	~	~
Lemstra (2003)	~	Yes	~	~	~	~	~
Bunn (2001)	~	Yes	~	~	~	~	~
Maniscalco (1999)	Yes	Yes	~	~	~	~	Yes
Shi (1993)	Yes	yes	~	Yes	Yes	Yes	Yes
Hilyer (1990)	Yes	Yes	~	~	~	~	~
Brown (1992)	Yes	Yes	~	~	~	~	~
Banco (1997)	Yes	Yes	~	~	~	Yes	Yes
Daltroy (1997)	Yes	Yes	~	~	~	~	~
Versloot (1992)	Yes	~	~	~	~	Yes	Yes
Tuchin (1998)	Yes	~	~	~	Yes	Yes	~

Table II-14. Literature Review Results: Details of Analyses, Outcomes, and Results of Intervention Effectiveness Studies.

Study Reference	Details of Analysis	Outcome(s) used in economic Analysis	Economic Analysis Results	Effectiveness outcome measures	Perspective of Analysis
Amick (2003); DeRango (2003)	Cost Benefit Analysis	Value of productivity per year	Benefit cost ratio was 24.61	Sick leave hours per month, productivity per effective day	Employer
Lahiri (2005)	Cost Benefit Analysis	1. Medical care costs associated with low-back pain cases; 2. value of lost work time due to sick leave (productivity); 3. Productivity loss due to low-back pain at work; 4. productivity enhancements due to intervention	Net savings per year were \$70.441	1. Cases of low-back pain; 2. sick days due to low-back pain; 3. medical care costs (incl. for no-lost time cases); 4. productivity	Employer
Rempel (2006)	Cost Benefit Analysis	Workers' compensation expenses	Payback period was 10.6 months	Incidence of neck/shoulder disorders	Employer
Bradley (1996)	Partial Economic Analysis	Workers' compensation expenses associated with	Savings were estimated to be \$442,515.61	Number and severity of RSIs	Employer

Study Reference	Details of Analysis	Outcome(s) used in economic Analysis	Economic Analysis Results	Effectiveness outcome measures	Perspective of Analysis
		RSIs			
Kemmlert (1996)	Cost Benefit Analysis		Payback period was 3 months	Value of sick leave/absenteeism (associated losses and expenses averted)	Employer
Tadano (1990)	Cost Benefit Analysis	Workers' compensation expenses associated with RSI claims	Net savings were \$53,053.34 over 6 months	Number of RSI claims	Employer
Wahl (1998).	Cost Benefit Analysis	Workers' compensation expenses per claim NB: all cases were either closed or had reserves assigned to them so that the expenses reflected full cost of claims	Benefit cost ratio was 17.8	Status of the claim (LT or NLT); workers' compensation expenses associated with the claim	System
Lewis (2002)	Cost savings with reduction of VDT-related WC claim	Workers' compensation expenses per claim	Average workers' compensation expense per claim decreased from \$15,141 to \$1,553	Injury rates and workers' compensation expenses associated with computer-related MSK claims	Not clear
Landstad (2002)	Payback period	Time loss expenses	Payback period was 46.4	Change in total time-loss expense at the individual level	Employer
Landers (2004)	Cost Benefit Analysis	Direct medical expenses	Benefit cost ratio was 8.86	Total claims, direct medical expenses, lost work days, reduced work days	Employer
Feuerstein (2000)	Partial Economic Analysis	Workers' compensation time-loss and health-care expenses	Time-loss expenses were reduced by 64%	Number of upper-extremity problems, work demands (measured by total hours of interpreting services)	Not clear

Laufer (1994)	Cost-effectiveness analysis	Number of needle stick injuries	Cost-effectiveness ratio was \$984 per injury averted	Number of needle stick injuries	Employer
Study Reference	Details of Analysis	Outcome(s) used in economic Analysis	Economic Analysis Results	Effectiveness outcome measures	Perspective of Analysis
Yassi (1995)	Cost-benefit analysis	Expenses associated with treatment of needle stick injuries	NPV ranged from additional expense of \$24,380 to savings of \$33,692	Number of needle stick injuries	Employer
Orenstein (1995)	Cost-effectiveness analysis	Cases of needle stick injuries	Cost of injury prevented was \$789	Number of needle stick injuries prevented (IV related; 3ml syringe related; disposal related; other)	Employer
Korniewicz (2005)	Before-after comparison of costs and consequences	Workers' compensation expenses	Lack of changes in workers' comp expenses can be compared to the reduced personnel hrs. required for storage and handling in amt of \$10,070	Number of reporting symptoms	Employer
Cameron (1997)	Cost-minimizing analysis	Consequences not considered since cost minimization study	Cost of gloves reduced by \$32,500	No outcome measures provided since cost-minimizing analysis	Employer
Collins (2004)	Cost-benefit analysis	Workers' compensation expenses (medical and indemnity payments) related to resident handling injuries	Payback period slightly less than 3 yrs.	Number of claims per 1,000 hours worked; rate of assaults	Employer
Chhokar (2005)	Cost-benefit analysis	Workers' compensation expenses	Lower- and upper- bounds payback period 2.50 yrs and 0.83 yrs respectively	Incidence and days lost from lifting/transferring/repositioning claims	Employer

Study Reference	Details of Analysis	Outcome(s) used in economic Analysis	Economic Analysis Results	Effectiveness outcome measures	Perspective of Analysis
Gundewall (1993)	Cost-benefit analysis	Value of absence days due to lower back pain	Benefit-cost ratio is almost 10	Incidence and duration of lost work days cases due to back problems	Not clear
Evanoff (1999)	Cost-consequences analysis	Workers' compensation expenses	41% decrease in expenses per worker, total savings of \$22, 758	Relative risk of injury and lost workday injury	Employer
Engst (2005)	Cost-benefit analysis	Workers' compensation expenses	Payback period 9.6 yrs if all claims considered; 6.5 yrs if only lifting/transf. claims	Number of lifting/transferring/repositioning injuries	Employer
Li (2004)	Before-after comparison of annual workers' compensation expenses per FTE	Workers' compensation expenses	\$484 pre-intervention expenses; \$151 post-intervention	Relative risk for lost workday injury	Employer
Ore (2003)	Cost-benefit analysis	Average (per claim) workers' compensation expenses	Cost benefit ratio \$5.80 per dollar invested	Number of manual handling injuries per 100 FTEs by age, sex, injury type, length of service in the agency, and job category	Employer
Brophy (2001)	Cost-benefit analysis	Total expenses of low-back injury (consisting of medical, compensation, and replacement wages expenses)	Total savings following intervention was \$546,500	Number of injuries per year, number of injuries per 100FTE nursing assistants, yearly average number of lost workdays, number of lost workdays per FTE, lost workdays per injury	Employer
Kemmlert (1996)	Cost-benefit analysis	Value of sick leave/absenteeism (and associated losses and expenses averted)	Payback period 1 month	Value of sick leave/absenteeism (associated losses and expenses averted)	Employer
Charney (1991)	Cost-benefit analysis	Workers' compensation expenses	Net value of 1 yr intervention was \$65, 000	Rate of back injuries per 1,000 FTEs	Employer

Study Reference	Details of Analysis	Outcome(s) used in economic Analysis	Economic Analysis Results	Effectiveness outcome measures	Perspective of Analysis
Guthrie (2004)	Before-after trends analysis of work-related injury expenses	Replacement and salary expenses for staff unable to work due to a work-related injury	Expenses declined to \$2,560	Number of lifting-related injuries	Employer
Linton (1992)	Cost-benefit analysis	Wage value of sick days due to pain	Employers would save at least twice the costs of program (\$9,715)	Number of days sick-listed for musculoskeletal Pain	Not clear
Yassi (1995)	Comparison of workers' compensation expenses between intervention and control groups	Workers' compensation expenses	total workers' comp Expenses for all back injuries decreased by 5% per 100,000 paid hrs. in intervention group	Number of reported back injuries per 100,000 hours paid	Employer
Bernacki (2003)	Before-after trends analysis of workers' compensation expenses	Workers' compensation expenses	Total workers' comp expenses decreased from \$0.81 to \$0.37 per \$100 payroll;	Number of lost-time claims per 1,000 workers, medical-only claims per 1,000 workers, temporary total days paid per 100 injured workers	Employer
Koviack (2004)	Post only analysis of savings	Value of time spent in temporary assignments rather than on disability	Savings in workers' comp expenses \$112,537 (2000), \$80,301 (2001), \$77,282 (2002)	Number of hours of temporary work assignments over a three-year period	Employer

Study Reference	Details of Analysis	Outcome(s) used in economic Analysis	Economic Analysis Results	Effectiveness outcome measures	Perspective of Analysis
Tracz (1992)	Post only analysis of savings obtained with wage costs associated with intervention	Wage value of time off work due to back injury claim	Estimated saving of \$3,135	Number of days lost to back pain	Employer
Davis (2004)	Before-after comparison (of workers' compensation expenses) of each of three years before the intervention with one year of the intervention	Workers' compensation expenses	RN's workers' comp savings between \$309,474 and \$143,796; health science professionals workers' comp savings between \$42,920 and \$128,180; facility support services workers' comp savings between \$32,900 and \$105,280.	Number of lost-time MSK injuries	Employer
Collins (1990)				Frequency, duration and incidence of lost-time back injuries	
Caulfield (1996)				Sick days (number and rate); days lost to workers' compensation; healthcare only and lost-time workers' compensation claims	
Martin (1995)				Frequency and severity of injuries	
Hocking (1991)	Net present value (NPV)	Manual and non-manual handling accidents expenses	NPV was \$3,995,000	Manual handling accidents	Employer

Study Reference	Details of Analysis	Outcome(s) used in economic Analysis	Economic Analysis Results	Effectiveness outcome measures	Perspective of Analysis
Lanoie (1996)	Net present value (NPV)	Direct and indirect medical expenses associated with back-related injuries	NPV was (-\$7,982.64); time period that incl. future projections, NPV was \$187,700.79	Back injuries resulting in a workers' compensation claim	Employer
Lahiri (2005)	Cost-benefit analysis	1) Medical care associated with low-back pain cases; 2) value of lost work time due to sick leave (productivity); 3) productivity loss due to low-back pain at work; 4) productivity enhancements due to intervention	Net savings per year were \$76,872	1) Cases of low-back pain; 2) sick days due to low-back pain; 3) medical care costs (incl. for no-lost time cases); 4) productivity	Employer
Lahiri (2005)	Cost-benefit analysis	1) Medical care associated with low-back pain cases; 2) value of lost work time due to sick leave (productivity); 3) productivity loss due to low-back pain at work; 4) productivity enhancements due to intervention	Net savings per year were \$2,334,409	1) Cases of low-back pain; 2) sick days due to low-back pain; 3) medical care costs (incl. for no-lost time cases); 4) productivity	Employer
Abrahamsson (2000)	Cost-benefit analysis	Value of absenteeism, production quality, and production efficiency	NPV was SEK 12,053,000	1) Absenteeism due to illness and occupational injuries; 2) measures of quality and efficiency of production	Employer

Study Reference	Details of Analysis	Outcome(s) used in economic Analysis	Economic Analysis Results	Effectiveness outcome measures	Perspective of Analysis
Halpern (1997)	Before-after comparison of workers' comp expenses	Workers' comp expenses	Total workers' comp expenses decreased from \$723,000 before intervention to \$420,000	Number of workers' comp. claims (total and musculoskeletal injury related claims)	Employer
Kemmlert (1996)	Cost-benefit analysis	Value of sick leave/absenteeism (and associated losses and expenses averted)	Payback period was 4 mos.	Value of sick leave/absenteeism (associated losses and expenses averted)	Employer
Kemmlert (1996)	Cost-benefit analysis	Value of sick leave/absenteeism (and associated losses and expenses averted)	Payback period was 3 months	Value of sick leave/absenteeism (associated losses and expenses averted)	Employer
Moore (1998)	Percentage change in workers' compensation expenses from baseline year	Workers' compensation expenses	Post-intervention, there was an 84% decrease in workers' comp expenses	Workers' comp. total claim incidence rate (per 100 workers), lost-time incidence rate (per 100 workers), workers' compensation expenses (total and per capita)	Employer
Ridyard (2000)	Trends analysis of workers' compensation indemnity and medical expenses	Workers' compensation expenses	1996 total savings: \$106,330-\$114,330; 1997 total savings: \$123,600-\$182,600;	Number of MSK injuries and associated lost days from work	Employer

Study Reference	Details of Analysis	Outcome(s) used in economic Analysis	Economic Analysis Results	Effectiveness outcome measures	Perspective of Analysis
Lemstra (2003)	Comparison of workers' compensation expenses per 100,000 hours worked (for all time-loss claims, upper extremity and back time-loss claims before/after and between two companies with diff. interventions)	Workers' compensation claim expenses (per 100,000 hours worked)	Total workers' compensation expenses under OC were \$6,028 vs. \$120,459 under EIP; workers' compensation expenses for upper-extremity MSK injury claims under OC were \$597 vs. \$73,136 under EIP; workers' comp expenses for back disorders under OC were \$287 vs. \$29,737	Upper extremity, back and all/total claims and their duration	Not clear
Bunn (2001)	Trends analysis of workers' compensation short- and long-term disability expenses	Workers' compensation expenses per worker, long- and short-term disability expenses per worker	Workers' comp expenses fell from \$687.60 to \$596.30; LTD expenses fell from \$172.57 to \$135.46; STD expenses fell from \$514.86 to \$460.57.	Incidence frequency rate per 100 employees for all cases and lost-time cases, number of long-term disability cases, controllable absenteeism as a percentage of all time off, workers' comp expenses, disability (STD & LTD) expenses, medical expenses,/health-care costs saved	Employer

Study Reference	Details of Analysis	Outcome(s) used in economic Analysis	Economic Analysis Results	Effectiveness outcome measures	Perspective of Analysis
Maniscalco (1999)	Cost-benefit analysis	Expenses associated with lost days and back injuries (medical expenses and productivity losses)	NPV were \$800,750 (reduction in lost workday injuries); NPV were \$167,085 (reduction in back injuries)	No-lost workday injuries (back injuries and all injuries), lost workday injuries (back injuries and all injuries), first aid cases, and levels of cholesterol, nutrition and fitness	Employer
Shi (1993)	Cost-benefit analysis	Lost-time and medical expenses	NPV was \$161,108	Back pain prevalence, health risk assessment	Employer
Hilyer (1990)	Partial economic analysis, comparison of post-intervention workers' compensation expenses for the intervention and control groups	Workers' compensation lost-time, medical, and total expenses	Intervention group: total workers' comp expenses were \$85,372; control group total workers' comp expenses were \$235,131	Flexibility	Employer
Brown (1992)	Partial economic analysis	Lost-time, medical, and total expenses	Total expenses for intervention group: \$47,269.71; total for control group: \$53,362.44	Number of back injuries, lost-work time, lost-time costs, total costs, medical costs	System
Banco (1997)	Cost-benefit analysis	Wage value of time-loss from work due to injury, workers' compensation (indemnity and medical care expenses)	Savings for Group A stores were \$29,413/year for the chain; Group B total net savings \$12,773 for the chain	Annual case cutter injury rate per 100,000 man-hours	Employer

Study Reference	Details of Analysis	Outcome(s) used in economic Analysis	Economic Analysis Results	Effectiveness outcome measures	Perspective of Analysis
Daltroy (1997)	Total expenses per back injury claim compared using the Wilcoxon rank-sum statistic	Back injury expenses	Median total expenses per back injury were \$309 for the intervention group and \$103 for the control group	Rate of low back and other MSK injury; time off work; likelihood of repeated injury	Employer
Versloot (1992)	Net present value (NPV)	Absenteeism expenses	NPV is \$103,400 if change in absenteeism for intervention group is assessed in relation to control group; NPV is \$70,200 if assessed only within intervention group	Number and length of absenteeism events	Employer
Tuchin (1998)	Costs and consequences considered separately	Absenteeism expenses	NPV was \$52,080	Days lost due to injury; Oswestry score for pain and disability; average expense of days lost per worker	Employer

Conclusions

The majority of these studies use workers' compensation expenses as the only cost measure. Workers' compensation expenses generally include the value of changes in health outcomes and the value of wages paid for lost time, or a combination of those two. The additional measures used are few and are primarily associated with lost work time, such as absenteeism.

Additional Efforts

In 2003, the *American College of Occupational and Environmental Medicine* (ACOEM) administered a questionnaire to nine Corporate Medical Directors, six of whom responded that their organizations were more focused on the values of health and

productivity management than cost. The survey also showed that the two of the three areas with the largest performance gaps were: disease management and absentee management. Both areas are at the forefront of IH responsibilities.

Other key findings included:

- a. Chief Financial Officers' (CFOs) concerns over healthcare go well beyond out-of-pocket costs. CFOs recognize a strong link between health, productivity, and corporate financial success.
- b. This strategic understanding does not help CFOs crystallize workforce challenges. They emphasize such traditional issues as attracting, retaining and training employees, rather than keeping them healthy, productive, and at work.
- c. CFOs have difficulty linking health benefits to the corporate bottom line. Their program success measures—costs, employee satisfaction and employee retention—are different from financial performance success measures (cash flow and growth in revenue and earnings).
- d. CFOs value workforce productivity as a means to financial success. CFOs would invest to change benefits management if a modest productivity gain would result.
- e. With the right information—keyed to the way they think—CFOs can be expected to understand and support the need for further investment in effective health-related benefits delivery.

Although the focus of the survey was on health benefit programs, the extension of these lessons to IH activities is an easy leap.

The ***National Business Group on Health***, an Institution dedicated to finding solutions to health care issues, presented the following four model types that can be used to determine the return on investments in health care by an employer.

Population-based models—defined as a “strategy for financial outcomes expected from a program that is based on demographic assumptions for an employer’s own population and savings or outcome results observed in published study results”

Assumption-based models—defined as a “strategy for financial outcomes that measures an employer’s own experience, typically both before and after a program/initiative is implemented, and links outcomes to the programs.”

Quasi-experimental—defined as a “strategy for financial outcomes that more directly links an employer’s own experience, typically both before and after a program/initiative is implemented, by developing a retrospective control group approach—matching a group of like members who participate to those who don’t participate in the program.”

Randomized controlled trial studies—defined as a “model for financial outcomes that is carefully constructed on a scientific basis to identify changes in outcomes, both before and after a program/initiative is implemented, by building a control group for whom the program/initiative is available and comparing results to a similarly-matched group for whom the program/initiative is not available.”

The following figure is a slide from a Towers Perrins HR Services presentation in June 2006 that provides a visual description of these return-on-investment methods.

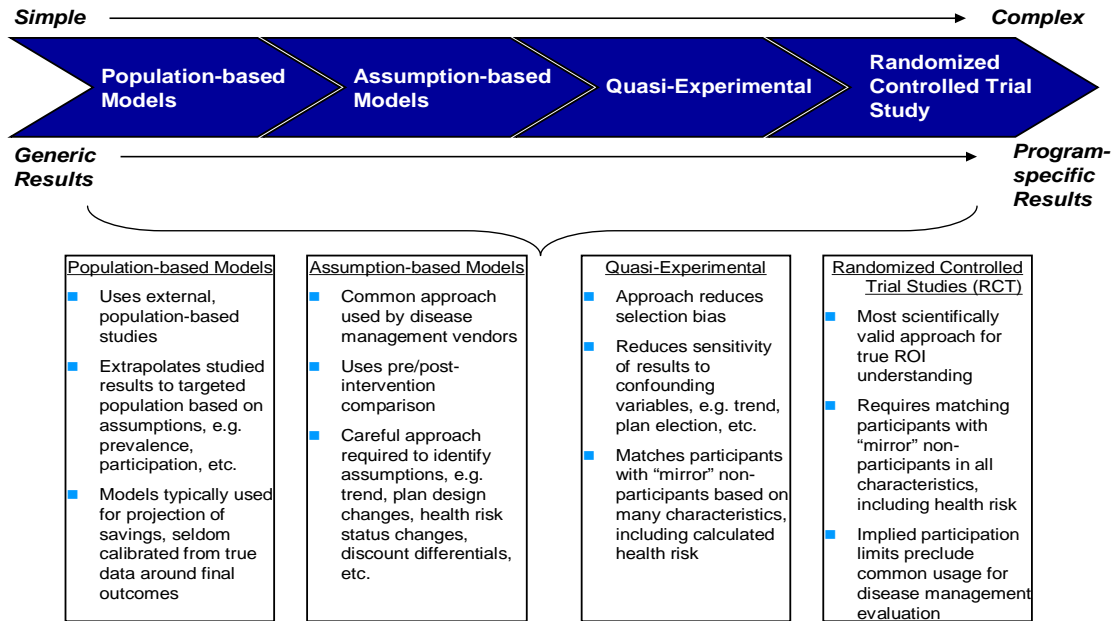


Figure II-4. Four Strategies for Determining Return on Investment (ROI).

In addition to providing the four study types, the group determined that it is important to provide a “multi-dimensional measurement approach.” They purported that the outcomes should include changes in health outcomes, changes in employee satisfaction, changes in productivity, and changes in business performance engagement. However, they did not provide methods to derive the value for each of the suggested parameters.

The Washington Business Group on Health and Integrated Benefits Institute’s work on EMPAQ (Employer Measures of Productivity, Absence, and Quality) began in 2001 when the Council on Employee Health and Productivity (CEHP) was formed. They specifically wished to address three questions posed by many Chief Executive and Chief Financial Officers. Those questions were:

- How is the firm doing relative to its operating plan?
- How is the firm doing relative to its competition?
- Who is considered best in class?

To answer those questions, the group developed quality and performance measures to determine the effect of health-related lost time programs. The measures of concern were cost, productivity outcomes, and administrative effectiveness. The group provided the following metrics descriptions to determine that effectiveness.

Table II-15. Metrics for Determining Effectiveness of Health-related Lost Time Programs.

Category	Metric Description
Cost	
	Benefit cost per employee
	Average benefit cost per claim
	Benefit cost as a %of payroll
Outcome/Productivity	
	Lost workdays per 100 employees
	Average claim duration
	Claim frequency
	Employee satisfaction
	Return to work effectiveness
	Family medical leave measures
Administrative Effectiveness	
	Timeliness of claim payment
	Accuracy of payment of benefits
	Timely decision of claim acceptance
	Accuracy of decision of claim acceptance

From these metrics, the group developed standardized reports for presentation of the information, which could be used to drive successful program evaluation and achieve the optimal goal of measuring and enhancing organizational health. The full-cost program includes what the program costs the employer, where that money goes in terms of claims, how much lost time has been incurred (a surrogate measure of productivity), and additional program-specific results that may be of importance to the enterprise.

Selecting Strategy Elements

As discussed in an earlier section, the value of the IH profession is determined by what the organization gets from their work; it is this impact or the effect they have on the organization. It was concluded that by reducing risk (the principle function of the Industrial Hygiene profession), the health of the employees will change; the business process will change and the work of the industrial hygienist will change and constitute the intermediate outcomes of an IH action.

These three categories of change have been incorporated in the *Qualitative and Quantitative Approaches* of the ***IH Value Strategy***. In the *Qualitative Approach* they were used to identify steps in the thinking process that translated risk reduction to business value. That effort is done by using a sequential cause and effect analysis to translate reductions in risk to changes in health, the IH risk reduction process, or the business process. The business impacts resulting from those changes are then isolated and a value case is then made for those impacts.

The comprehensive list of potential changes that comprise the first layer of intermediate outcomes is provided below. These changes were drawn from existing strategies and the reviewed literature.

Table II-16. Potential Changes Resulting from IH Work.

Changes in:		
Health Outcomes:	IH Management	Business Process
Mortality	Duties	Process Design
Injuries	Responsibilities	Equipment Needs
Illnesses	Administrative Load	Management Efforts
Disabilities	Recording Keeping	Work Flow
Quality of Life	Hierarchy of Controls	Materials
Functionality	Monitoring	Pace
Mental Health	Medical Surveillance	Inputs

The list of changes needed to be followed by a similar list of the impacts that these changes produced that correlate with the identified intermediate outcomes—health outcomes, IH management functions, and business processes. A number of analytical tools or methods could have been used to determine the elements that are impacted by the IH activities, including process maps, cause-and-effect matrices, and causal loop diagrams.

The list of business impacts follows:

Table II-17. Potential Business Impacts Resulting from IH Work.

Related Impacts:		
Health Outcomes:	IH Management	Business Process
Absenteeism	Staff Levels	Process Steps
Presenteeism	PPE Costs	Raw Materials
Insurance Premiums	Training	Cycle Time
Labor Turnover	Equipment Maint./Calibration	Staff
Medical Removal	Operational Downtime	Equipment
Job Transfers	Process Interruptions	Maintenance
Training/re-training	Other	Waste
Worker Productivity		Environmental Emissions
Other		Compliance Pressures
		Other

These items are discussed in more detail in the section describing Phase III.

In the *Quantitative Approach*, the categories are used to organize the user’s thinking on key business and financial measures.

Risk reduction is related to the same three categories—changes in health status, the IH risk reduction process, and other business processes. Health changes focus on the impacts of risk reduction on fatalities, days away from work injuries and illnesses, restricted work injuries and illnesses, and medical treatment injuries and illnesses. To gauge the impact of the risk reduction on the IH risk management process and other business processes requires a detailed assessment of the impact on capital costs, operating costs, costs related to managing the IH risk, and costs of IH incidents related to the hazard. There are detailed parameters for each one of these subject categories—selected as a subset from the ROHSEI categories listed above and supplemented with parameters identified in some of the site visits conducted as part of this study.

The *Quantitative Approach* has less sequential steps than the *Qualitative Approach*, but examines each step in significantly more detail.

Identifying Key Interrelationships Between Strategy Elements

The individual strategy elements have maximum value when they are interrelated. To identify key interrelationships the team chose to employ the ROHSEI *Causal Loop Diagram*, which has the ability to identify complex processes and root causes. Through a chain of causes of effects, the tool provides a visual demonstration of how variable *A* affects variable *B* and how variable *B* affects variable *C*. When all causes, effects, and interactions have been explored, the behavior of the entire system (in this case the IH function) will be revealed. William Rushing, publishing for Six Sigma, has touted the strength of this tool by stating “only through this thorough analysis can an organization make changes that are lasting.” The following diagram demonstrates a first level of analysis indicating the relationship between ill employees and productivity.

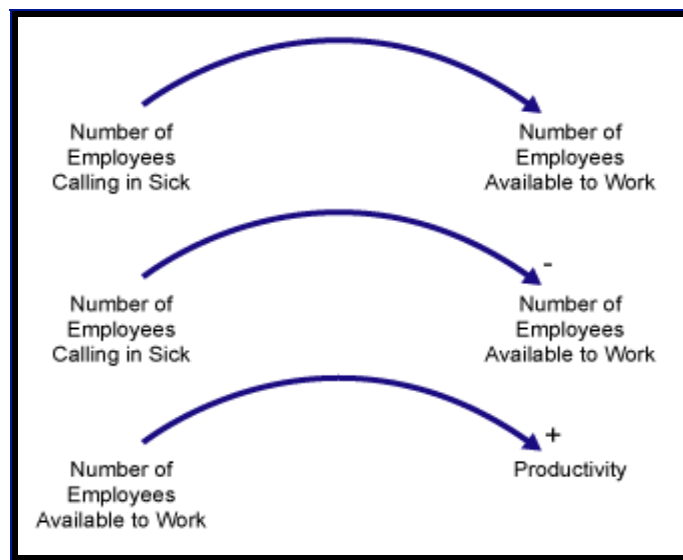


Figure II-5. First Level of Analysis Example.

This subsequent analysis demonstrates more clearly the relationship between employees available to work, productivity, and the impact of a positive change in productivity.

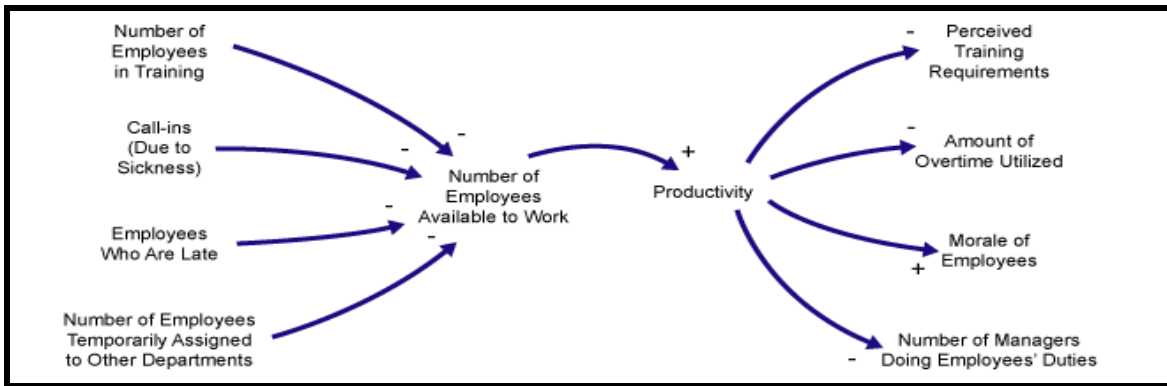


Figure II-6. Causal Loop Diagram Example.

The second reason that the team selected the *Causal Loop Diagram* tool was that it is an integral part of the ROHSEI system, which has been used for well over 10 years. Additionally, it demonstrates the relationship of reduction in risk to health outcomes and business process intermediate outcomes. The following diagrams are included in the documentation for the ROHSEI strategy and are presented below for illustrative purposes.

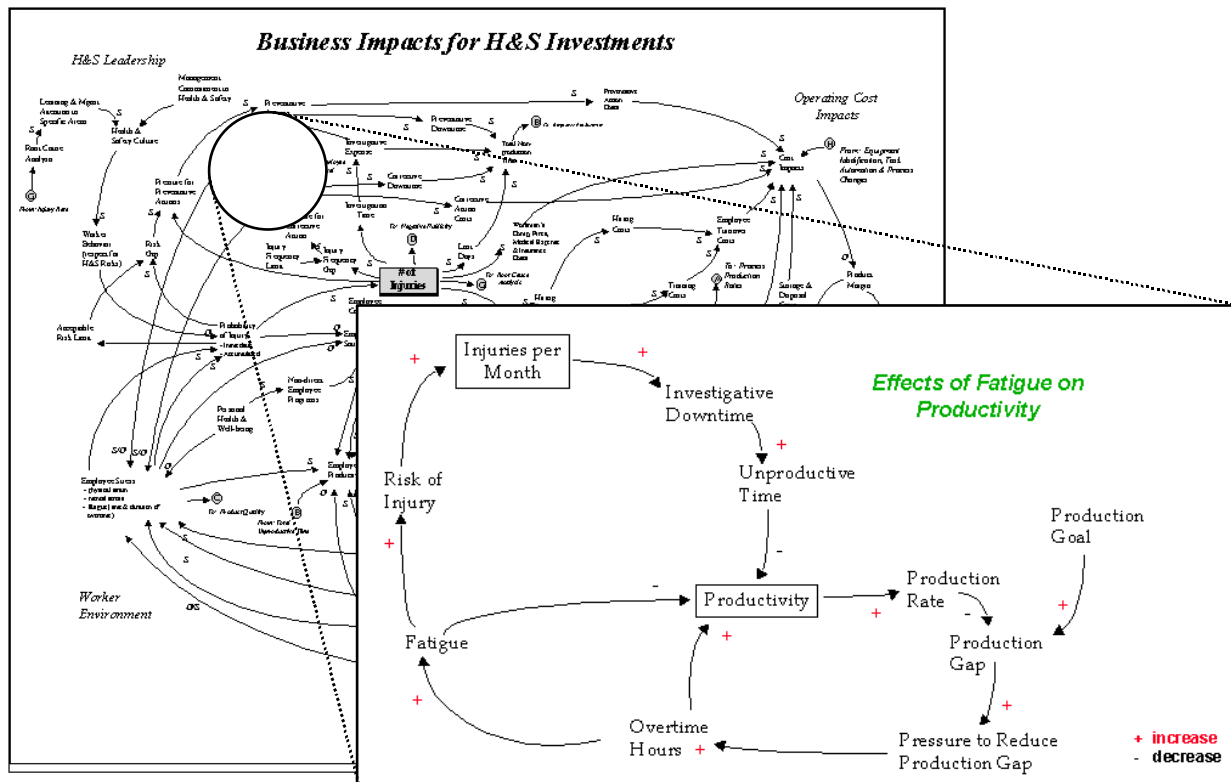


Figure II-7. Causal Loop Diagrams from ROHSEI Documentation.

Combining information from case studies using ROHSEI tool, published works, and brainstorming sessions of the team, Table II-18 presents elements that represent the impacts from change that were incorporated into the *IH Value Strategy*.

Table II-18. IH Value Strategy Impact Elements.

Impact from Changes in:		
Health Outcomes:	IH Management	Business Process
Days away from work	Staffing requirements	Number of steps needed
Absenteeism	PPE needed	Qty and type of materials
Presenteeism	Training needs	Time allotments
Medical care	Equipment maintenance	Waste
Restricted work activity	Calibration activities	Compliance pressures
Labor turnover	Downtime	Environmental emissions
Employee physical capacity	Time allocation	Staffing requirements
Medical removal	Process interruption	Equipment needs
Job transfer		Maintenance

As was demonstrated in the *Causal Loop Diagram* discussion, these elements are interrelated—one element may affect another element within the initial intermediate outcome or among intermediate outcomes. However, while there are some universal relationships, each IH activity or program should be evaluated to best demonstrate the extent of the resulting impact.

The next step explores the methods to identify appropriate sub-elements to demonstrate the value of these elements which represent the impact on the intermediate outcomes that resulted from changes in those outcomes that occurred because of changes in risk.

Experience Using Selected Strategy Elements

Past Experience Using Selected Strategy Elements in ROHSEI

Over the last 10 years, the ROHESI strategy has demonstrated the validity of collecting and valuing sub-elements resulting from the impact of specific occupational safety and health activities and programs to the business enterprise. Data collected using the ROHSEI sub-elements, parameters as defined in that strategy, can be aggregated to show the impact on intermediate outcomes (employee health, IH risk management process, and business process) that are defined in this *Strategy*.

Summaries of ROHSEI analyses were developed to identify what sub-elements were considered and the relationship of those sub-elements to the elements (or intermediate outcomes) named within this *Strategy*. These case studies were revisited following the creation of the *Quantitative Approach* to validate the ability of the user to access the data, to understand the elements, and to calculate the costs and benefits as well as determining if the major cost categories (operating and capital) were included. The following section presents pertinent information on a case study that used ROHSEI to determine the cost-benefit of an occupational safety and health intervention. The remainder of cases that were examined can be found in Appendix A.

Process Hazard Assessment Case Study Validation

The ROHSEI case study determined the value of a process hazard analysis for a representative chemical process step. The PSM program incorporated 4 elements with defined costs for each step. The value of a PSM program includes the financial benefits associated with reduction of risk as defined by reduced probabilities and consequences of process safety incidents.

The company used “Design and Engineering Personnel Time” to calculate what would be considered the total operating costs within the data element “design and engineering” in the quantitative tool. This resulted in an improved business process and reduced the level of risk by engineering out the problems.

The company used “Emergency Response” to calculate what would be considered the total operating costs within the data element “total other costs related to the current method of managing the risk” in the quantitative tool. This resulted in no significant increased cost associated with PSM directly, but reduced the level of risk.

The company used “Operational Personnel Time” to calculate what would be considered the total operating costs within the data element “Operation Personnel Time” in the quantitative tool.

The company used “Operations and Maintenance” to calculate what would be considered the total operating costs within the data elements “operating costs” and “maintenance costs” in the quantitative tool. The incorporation of these elements allowed for an improved business process and a reduction of risk.

The Process Hazard Assessment case study indicated:

1. The user had access to the data
2. The user understood the elements
3. The user understood the elements over time
4. Different users understood the elements
5. The user was able to calculate the value.

Figure II-8. Sample Case Study.

Experience from the Current Study

In addition to examining cases collected over the past 10 years of ROHSEI application, current cases from project site visits were used to test the strategy and were analyzed to determine the viability of the elements found in this strategy.

The questions asked were:

1. Is the element the right one for the strategy?
2. Are its key sub elements listed correctly?
3. Is it correctly named? Will the users know what it means?
4. Is it adequately defined, so that consistent answers will be given by different users?
5. Will it be consistently interpreted over time?
6. Do companies have the data to support it?

7. Will the industrial hygienist be able to access the data?

In general, the results indicate that collecting and valuing the elements for this strategy are viable. A sample site visit validation follows; additional case results are presented in Appendix E.

Table II-19. AIHA Value of the Profession Data Element Analysis Matrix.

AIHA Value of the Profession Data Element Analysis Matrix						
QUANTITATIVE ELEMENT	DATA ELEMENTS					
CASE STUDY: COMPANY A	Health	Risk Management				
Data Element Criterion	Total Cost of Occupational Illnesses or Injuries	Total Capital Costs	Total Operating Costs	Total Medical Surveillance Costs	Total Other Costs Related to the Current Method of Managing the Risks	Total Non-Medical Costs of Incidents
1. Is the element the right one for the model?	Company A incorporated the element by number/type and costs	Company A incorporated the element by equipment and installation	Company A incorporated the element by expressing the changes in various sub-elements. For example, pre-intervention costs included monitoring, which were eliminated post- intervention.	Company A incorporated the element by addressing incremental annual cost of medical staff, facilities, supplies and contracts for keeping track of noise issues.	Company A did not use this element for the analysis.	Company A incorporated the element through calculating costs associated with reporting/investigating incidents, coordination with IH, and contracting with vendors. All costs were defined within various sub-elements dependent on time spent.
2. Are its key sub elements listed correctly?	Company A considered recordable hearing shifts and cost per case.	Company A considered these costs to be routine expenses for air sources, air nozzles in gortex and internal labor for installation.	Company A was able to distinguish between operational (Non-IH) time, IH safety staff time, other time, and consultant time. They were then able to show the differences between these sub-categories before, during and after the intervention.	Company A was able to distinguish these costs from others as they are directly related to the medical costs rather than incident-related costs.	Company A did not use this element for the analysis.	Company A was able to distinguish these costs based on strictly incident related costs rather than medical costs.
3. Is it correctly named? Will the users know what it means?	Company A was able to determine the type of cost data belonging in this element	Company A was able to determine the type of cost data necessary for the element.	Company A was able to determine the type of cost data necessary for the element, according to time spent within operational (Non-IH) time, IH safety staff time, other time, and consultant time.	Company A was able to determine the type of cost data necessary for the element.	Company A did not use this element for the analysis.	Company A was able to determine these costs based on strictly incident related costs rather than medical costs.
4. Is it adequately defined, so that consistent answers will be given by different users?	Company A provided fact based (consistent) data of cost and number/type of illness.	Company A provided the same cost data for before and during the intervention.	Company A provided operating cost data based on time spent within the various sub-elements. The sub-elements do not allow for double-counting, providing a consistent basis for data collection. Each category is defined so users will know what costs to include and exclude.	Company A provided medical cost data based on strictly medical and not incident-related data.	Company A did not use this element for the analysis.	Company A provided fact based cost data for each sub-element and did not double count for other parameters.
5. Will it be consistently interpreted over time?	Company A considered the elements to be sufficient for collecting data on occupational illness costs necessary for retrospective and prospective analysis.	Company A considered these costs to be the same type of elements that would be needed for retrospective and prospective analysis.	Company A considered operating costs to include the same type of elements that would be needed for retrospective and prospective analysis.	Company A considered medical surveillance costs to be the same type of elements that would be needed for retrospective and prospective analysis.	Company A did not use this element for the analysis.	Company A considered the costs associated with reporting/investigating incidents, coordination with IH, and contracting with vendors to be the same type of elements needed for analysis in the future.

Conclusions

The Contract and Statement of Work called for a list of model elements reviewed, model elements selected for further analysis, correlations found among model elements, sensitivities found among model elements and between model elements and intermediate business results and impacts, and methods used to assess specific IH program/activity contribution to intermediate outcomes and business results.

The purpose was to assess various program elements' suitability for inclusion in the *Qualitative* and *Quantitative Approaches*.

In Phase II, additional work was needed to identify and fully assess potential model components. Therefore, in addition to the contract requirements, the team defined key concepts and terms, conducted a comprehensive literature search, and explored existing models that were thought relevant to making the value case for industrial hygiene. Once model elements were identified, the interrelationships between model components were examined using the ROHSEI *Causal Loop Diagram* that has been in use for more than a decade. Finally, the potential model elements were evaluated by examining cases in the ROHSEI User's Library. (Again, these reflect more than a decade of experience.) In addition, strategy elements were assessed based upon the site visits and case studies undertaken as part of this study.

After reviewing the literature, analyzing existing models, and re-examining its own experience in demonstrating value, the study team concluded that the best way to capture the value that IH brings to the business was to start with the IH risk reduction process and track its impact on employee health, the industrial hygiene risk management process, and the business process in general. Impacts can be quantifiable in terms of reduced cost or even added revenue, or they may be more general contributions to key business objectives.

Model sub-elements and parameters can be imported from the existing ROHSEI tool and from other models and sources. These elements are listed in the Phase III, IV, and V sections of this report. They clearly passed the first tests applied to them in completing this phase of the work concerning reasonableness, clarity of definition, and accuracy and consistency of result. However, they will no doubt be improved over time through continued use and re-evaluation.