

Risk Management Decision Criteria

Risk management is often a multi-criteria decision making process in which economic, health, legal, environmental, social, geo-political and other factors come into play. It is the risk managers' responsibility to appropriately weigh these factors and decide on a course of action.

Because the decision making process can be complex, there is no one decision criterion that must be or is always used. Nonetheless, there are several decision criteria that recur with some frequency. They include: cost-benefit analysis; cost effectiveness analysis; risk-benefit analysis; and, comparative risk analysis. They are described briefly below.

Cost-Benefit Analysis

We can't do everything. That is a simple fact of life. Because we cannot do everything we have to make choices. Choosing more of one thing simultaneously means choosing less of something else. For example, rejecting a large shipment of grain for possible aflatoxin contamination increases food safety. But it comes at a cost of reduced food supplies. Choices have costs.

We are often willing to bear the costs of our choices because the benefits associated with our choices outweigh their costs. Most individuals have some innate ability to weight costs and benefits from their personal perspectives as they make choices on a daily basis in their own lives. You may readily decide that an apple is well worth the price that is being asked for it and buy it while another person may consider the price too high and decline to buy it. The values we place on things are highly personal in origin. As long as the choices affect only us we encounter relatively few problems. But suppose a hungry person were given the choice of eating or not eating some of that grain from a possibly contaminated shipment. Would they fear starvation or aflatoxicosis more? Who decides whether they will even have that choice?

The problems can become quite complex when governments make choices that affect thousands or even millions of people. What weights should we use when deciding whether to ban aspartame or not? How much aflatoxin is acceptable? Should antibiotics be routinely used in chickens? Will we allow the sale of irradiated meats or not? Government actions, interventions and policies can have far reaching impacts on a wide variety of stakeholders.

Cost-benefit analysis is an analytical tool that can be used to answer the question, "Is it worth it?" of every government action, intervention and policy that can affect food safety. When the impacts of a government action, intervention or policy can be identified, measured and quantified in dollars it is a straightforward matter to answer this question. When the impacts cannot be identified or measured, cost-benefit analysis is problematic. In other cases, impacts can be identified and measured but they cannot be quantified in dollar terms. Loss of life is a classic example of a measurable impact that cannot be easily quantified in dollar terms. Even when all impacts cannot reasonably or reliably be reduced to dollar terms cost-benefit analysis still provides a useful framework for structuring one's thinking about the trade-offs encountered among incommensurable values.

Consider a few simple examples of the implicit cost-benefit analysis we do all the time. You are offered eight hours of overtime on the weekend. It will cost you a picnic you had planned for that day. If you say yes to the overtime you have implicitly determined that the things you will consume with the overtime income earned provide you with greater utility than the picnic would have. If you say no to the overtime you have implicitly determined the picnic is worth more to you than the overtime income you forgo to attend the picnic.

Or suppose you walk into a convenience store and see a favorite candy bar on sale for \$0.50. If you buy it you have implicitly decided that the pleasure you obtain from the candy bar exceeds fifty cents, otherwise you would not have bought it. With small purchases of little consequences our cost-benefit calculus is almost instantaneous, so much so we rarely realize we are doing it. But when the consequences of a purchase grow in importance so does the thought we give it.

Few of us buy a car the way we buy a candy bar. The trade-offs are much more explicit. What will it cost to get another year out of the current car? How badly do you want that new car smell again? What will the payments be? How long will they last? After a more or less detailed thought process you arrive at a decision in which you have explicitly or implicitly weighed the pros (benefits) and cons (costs) of purchasing a new car. When the pros outweigh the cons and you are able to afford it, you buy the car. When the cons outweigh the pros you do not buy the car.

When the government is going to decide whether or not to allow imports of grain from another country it must consider its own grain farmers, buyers of the grain, consumers of the grain, future citizens who might be affected by a reduced domestic grain yield related to non-indigenous diseases associated with the exporting country, and so on. On the one hand, trade might supplement grain supplies for many years to come. This will reduce hunger and malnutrition in the nation. On the other hand there is some chance, however small, that the imports could unleash a fungus that could reduce grain yields resulting in a famine that could claim lives. What should the government do? Knowing the benefits and costs of each option, i.e., allowing or forbidding imports, will not provide an answer, but it will provide a great deal of useful information that will be helpful in arriving at an answer.

Cost-benefit analysis or benefit-cost analysis is not a course of action or an answer. It is not a decision. It is a systematic, analytical technique that informs decisions. It is an aid to decision making. At a very practical level, it is simply a fact that knowing the costs and benefits of an array of alternative actions is very useful information.

Although each cost-benefit analysis is unique, there are some recurring tasks worth noting. A dozen of them are offered to illustrate the general manner in which cost-benefit analysis is conducted.

Step 1. Who is the client? Every analysis requires a perspective or a point of view. The purpose of this step is to make the perspective of the analysis clear to the analyst. The perspective defines the scope of benefits and costs considered. For example, if you are attending a holiday party the costs are seen much differently than if you are having the party. Likewise, the costs of an import ban differ from the perspective of the consumer and the competing market grain farmers. In most cases a cost-benefit analysis of a government action, intervention or policy takes a national or societal perspective. It usually considers net gains to society as a whole in quantifying benefits and costs.

Step 2. What are the goals of the analysis? This is a matter of defining the problem. The problem might be deciding whether to go to that holiday party or not. Or it could be deciding whether to allow the importation of foreign grains from a particular country over a particular time frame. These should be specified as part of the risk management process.

Step 3. What specific question(s) is the analysis trying to answer? This involves the critical step of getting the question right. If our objective is to minimize unnecessary uses of our time we might make a different decision about attending the party than we would if we are trying to minimize our food budget. Maximizing net benefits to society might be a reasonable objective for the grain import problem. Minimizing the costs of providing a grain supply of a given size might be another objective. These questions should be specified as part of the risk management process.

Step 4. What are the risk management alternatives? The analysis should estimate benefits and costs each risk management option under consideration. The risk analysis team as a whole will identify risk management options. Each will have its own benefits and its own costs. A separate cost-benefit analysis is done for each alternative. Because risk analysis is an iterative process the estimation of benefits and costs becomes more precise as the risk analysis progresses even as the number of viable alternatives is narrowed to a final choice.

Step 5. What are the impacts of each risk management option? Each risk management option will have its own unique effects, intended and unintended. These effects or impacts give rise to benefits or costs. The outcomes of a government intervention are presumably benefits, although they can include costs as well.

The resources required to implement a government action, intervention or policy constitute costs. In answering this question the analyst is required to identify the ranges of impacts associated with each risk management option. Examples might include costs to industry, enforcement costs, increases in consumer surplus, reductions in health care costs and so on.

Step 6. How are the impacts to be identified? The goal is to identify impacts that can be directly attributed to the risk management options. Before and after analysis and gap analysis are two common ways to identify impacts. The preferred way for cost-benefit analysis is to use a without and with alternative comparison. The without alternative condition is a description and quantification of the most likely future values of important impacts if no risk management option is implemented. It is a do nothing alternative that provides a baseline measure for the future. A with alternative condition is analyzed for each risk management option separately. This is the most likely future value of the important impacts if a particular action is taken. The differences in these two conditions comprise an estimate of the alternatives' impacts. The table below illustrates the idea with a hypothetical example.

	Without	With Plan 1	Plan 1 Change	With Plan 2	Plan 2 Change
Cost to Industry	\$100M	\$150M	+\$50M	\$200M	+\$100M
Health Care Cost	\$1000M	\$900M	-\$100M	\$500M	-\$500M
Enforcement Cost	\$0	\$50M	+\$50M	\$250M	+\$250M
Consumer Surplus Change	\$0	\$25M	+\$25M	\$20M	+\$20M

The impacts attributable to a risk management option (Plan 1, Plan 2) are based on a comparison of the impact (cost to industry, health care cost, etc.) with the alternative in place (With Plan 1, with Plan 2) to the baseline do nothing condition (Without). There is no enforcement cost if no action is taken. The costs to enforce Plan 2 are \$250 million and so the impact of Plan 2 is the difference between these two conditions, in this case \$250 million.

Step 7. How are impacts to be valued? Some impacts can be easily quantified in dollars. Others can be quantified in dollars but not quite so easily. Still other impacts cannot be quantified in dollars at all. In this step it is appropriate to choose both the units of measurement and the techniques for measuring the value of an alternative's consequences. This is the heart of cost-benefit analysis. In the table above all changes are in dollars. Lives saved would be an example of an impact that might be measured in something other than dollars.

Step 8. Do the analysis. The all-important steps of data collection and analysis are conducted at this step in the process.

Step 9. How certain are the predicted consequences? Forecasting the most likely values of important impacts in the future under different scenarios, for example do nothing, Plan 1, Plan 2 and so on, is a fundamental exercise in uncertainty analysis. Outcomes of risk management options and the costs of implementing them are likely to be uncertain. The uncertainty in key benefits and costs should always be explicitly addressed. It is often preferred to express benefits and costs as distributions and use a probabilistic estimate of the net benefits or benefit-cost ratio.

Step 10. What is the risk management choice? In this step of the analysis the results of the cost-benefit analysis are drawn together with the other important risk management values relevant to the choice of the best option. These options are then presented to the decision-maker for consideration. The process of presenting the choice may involve a more or less formal decision methodology. A decision criterion such as net benefits, a benefit-cost ratio or the internal rate of return may be used to convey this information.

Step 11. What is the decision? The presentation of choices inevitably will require some type of additional trade-off analysis. Risk managers and other decision-makers will weigh the results of the cost-benefit analysis and the other relevant values to make a selection of a course of action from among the available alternatives.

Step 12. How do outcomes compare with predictions? The analyst should monitor outcomes and compare the actual results with the predicted impacts. This step is often ignored in practice. It is an essential element of any adaptive risk management strategy.

The results of a cost-benefit analysis are most often presented as a benefit-cost ratio, note the reversal of terms here, or as net benefits. Because both the benefits and costs of risk management options can occur in complex patterns over time it is necessary to address these issues of differences in price level and time value in all money flows. This is done primarily through the process of discounting and compounding money values appropriately.

Both benefit-cost ratios (benefits divided by costs) and net benefits (benefits minus costs) are usually based on the accumulated present value of all benefits and costs. This simply means the analyst has appropriately accounted for and appropriately adjusted all money values over the relevant planning horizon. The planning horizon or discounting period is the number of years into the future over which the risk management options impacts are being considered.

A benefit-cost ratio (BCR) in excess of one means that the option will return more than a dollar (or other currency unit) for every dollar spent. Projects with benefit-cost ratios less than one are considered economically inefficient because they do not “cover” their costs. There may, however, be other reasons that offset the choice of an option with a BCR less than one.

Net benefits in excess of zero result when a project has a BCR greater than one. Negative net benefits indicate an economically inefficient, i.e. wasteful, option. Net benefits are the preferred measure of a project’s efficiency because they provide a measure of the magnitude of the economic consequences. A BCR provides the average return per dollar without indicating the overall impact.

The choice of decision criterion can affect the ranking of projects, as the table below illustrates. Plan A would appear to offer a nice return on the investment based on the BCR. Plan B clearly improves social welfare by a more substantial amount as net benefits indicate. The ranking of these two plans depends on the criterion used. Net benefits are preferred by most economists for public sector projects.

	Total Benefits	Total Costs	BCR	Net Benefits
Plan A	\$3	\$1	3.0	+\$2
Plan B	\$150,000,000	\$100,000,000	1.5	+\$50,000,000

In risk management, all other things equal, the preferred option is the one with the greatest excess of benefits over costs. The option with the greatest net benefits is preferred unless there are non-economic trade-offs that enter into the risk management decision.

In the private sector the internal rate of return (IRR) is sometimes used as the cost-benefit analysis decision criterion. The internal rate of return is the interest rate at which the accumulated present value of benefits exactly equals the accumulated present value of costs. If project financing can be obtained for the IRR or a lower rate the project is considered worthwhile.

Cost Effectiveness Analysis

Cost effectiveness analysis is a technique that identifies the most cost effective, i.e., least cost, way of meeting a specific goal. The goal is often set through a separate process, such as a government mandate or a legislative goal. In most instances the benefits of the goal are not explicitly estimated. Thus, the

economic analysis concentrates wholly on the costs of obtaining a specific level of some desired output or outcome of an action, intervention or policy.

Once a goal is set, for example to reduce foodborne illnesses due to a specific pathogen by 20 percent, the risk analysts review a range of alternative approaches for reaching this goal and choose the least costly alternative.

Implicit in this approach is the judgment that the benefits of achieving the goal outweigh the costs of achieving the goal. Benefits are not explicitly estimated for this technique.

Cost-effectiveness differs from cost-benefit analysis in only two respects. First, there is a specified level of output or goal achievement. Second, benefits are not explicitly estimated. In all other respects the two techniques are quite similar. The steps identified in the cost-benefit analysis section are equally applicable for cost-effectiveness except for these two differences.

Risk-Benefit Analysis

The description of cost-benefit analysis is based on a trade-off of benefits and costs. Risk-benefit analysis is based on a similar kind of trade-off between risks and benefits. Driving and sky-diving are both undeniably risky activities. Many more people drive than skydive. One simple explanation for this is that the benefits of driving are more broadly recognized than are the benefits of skydiving.

Driving enables us to live and work in disparate places. It facilitates great personal mobility and contributes significantly to the quality of our lives. Indeed it does present significant risks, but most of us who drive have implicitly decided that the benefits of driving outweigh the risks of driving. On the other hand, relatively few of us look at the thrill and exhilaration of skydiving and judge those benefits to exceed the risks of that activity. In general, the greater the perceived benefits of an activity the more risk we are willing to bear.

If one recognizes the risks associated with driving, sky-diving, trade with a new partner, new food safety technologies, food additives and so on as a special kind of "cost," risk-benefit analysis begins to look like a special case of cost-benefit analysis. Nonetheless, it differs from cost-benefit analysis in several significant ways.

Risk-benefit analysis is not concerned with the costs of a government action, innovation or policy. It concentrates on the risks of interest to the decision process. For example, a decision to add boric acid to a food package to help hold the colors of the package entails certain benefits to buyers and sellers. Consumers can more readily find the packages they seek and it may also be easier for them to gain information that may be useful to their decision whether to purchase the product or not. The seller benefits from the marketing advantages of an attractive package. But boric acid could migrate into some foodstuffs, potentially increasing a lifetime cancer risk.

The benefits in a risk-benefit analysis may or may not be quantified in dollar terms. In this respect it can differ significantly from a cost-benefit analysis which prefers benefits measured in monetary terms. In some cases benefits may be quantified in a very qualitative way, such as in the preceding example. In other instances they may be quantified in a variety of different metrics, none of which may entail dollars.

The risks associated with an action, intervention or policy vary from one risk analysis to the next. Unlike cost-benefit analysis there is no single decision criterion used to aid the decision process. All the relevant risks are piled up against the relevant benefits of the risks and risk managers must select a best option from among the alternatives available to them.

When benefits can be expressed in dollar terms the comparison becomes a bit simpler, especially when the risks are expressed in a common metric as well. Dollars of benefits per statistical death would be a metric that lends itself easily to comparison in a manner similar to that used in cost-benefit analysis. It is more

common, however, for the benefits of risk management options to vary and the metrics used to quantify them may include such things as lives lost, days of sickness prevented, political support, and so on. The risks of a risk-benefit analysis typically result from the risk assessment. Identification of a risk management option's benefits and quantification of those benefits in an appropriate metric to the extent possible represent a substantial contribution to the risk management process. Basing decisions on the relative risks and benefits of the various options adds structure and transparency to the decision making process.

Comparative Risk Analysis

The comparative risk analysis process is designed to reach consensus on which food safety problems pose the most risk to human health and quality of life. In practice there is some confusion over just what this term means. Some think of it as a communication device in which analysts compare relatively unknown risks to more common risks in hopes of improving communication. For example, you are more likely to be injured in your own bathroom than you are to get ill from eating food with this in it. That is not comparative risk analysis. That is simply comparing risks.

The U.S. Environmental Protection Agency has begun using this term to describe their own process of bridging science and public values to establish environmental priorities. Extricating the terminology from the specifics of the EPA program is important. The aim of the risk assessment process is to evaluate and rank the relative magnitude of risks associated with problem areas on the basis of the best available scientific information and judgment. These risk-based rankings then serve as a key input to the risk management process. During the risk management process other values are integrated with the relative rankings of the risks to select appropriate risk management options