The Effectiveness of a Costs and Benefits Analysis in Making Federal Government Decisions: A Literature Review

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ABSTRACT

Cost-Benefits Analysis (CBA) is the process of using theory, data, and models to examine products, tradeoffs, and activities for assessing relevant objectives and alternative solutions (Womer, Bougnol, Dula, & Retzlaff-Roberts, 2006) in order to assist decision-makers in choosing the most appropriate alternative. This paper explores how CBA may best be used, focusing on the effectiveness of CBA during the early phase of a program life-cycle in ensuring that there are viable alternatives in making investment decisions. It addresses program importance, cost estimation, and the decision-making process in order to understand the overall effectiveness and efficiency of CBA in making key investment decisions and enforcing accountability among program managers. It also examines the measures and the methodology used to develop a CBA, addresses the accuracy and reliability of CBA, and identifies techniques available to support decision-making in the early phase of a program's life-cycle. It also notes, however, that because not all costs and benefits can be quantified, measures other than CBA should be considered in making investment decisions.

INTRODUCTION

Cost-Benefits Analysis (CBA) grew out of the research programs of the RAND Corporation and similar organizations in the field of defense research in the period shortly after World War II (Casebeer, Raichle, Kristofco, & Carillo, 1997). The use of CBA is required by law and regulation throughout the federal government for deciding among alternative policies and programs (Womer, Bougnol, Dula, & Retzlaff-Roberts, 2006). CBA is a mathematical tool used by decision-makers to determine if the perceived program benefits outweigh expected costs (Makowsky & Wagner, 2009). Nonetheless, the use of CBA is controversial. Makowsky and Wagner (2009) noted that analysts have deep practical concerns about using CBA in dealing with discount rates, opportunity costs, prices, distributional weights, and evaluation criteria. Some critics even argue that CBA is not effective and therefore should not be used.

One of the key problems with CBA is that it is prone to misuse and to misunderstanding, particularly regarding the intent for which a CBA is used. For example, a CBA cannot stand alone in the decision-making process. It cannot change policy and it is not intended to act as a political enforcer. However, it can support investment decisions in response to changing demands. Specifically, a CBA represents an independent study that compares the costs and benefits of two or more viable and mutually exclusive alternatives (not including the status quo) in order to make an effective decision on a preferred alternative.

Many studies argue that CBA is ineffective and often inappropriate in the areas of safety, health, and environmental regulations (Kornhauser, 2000). Indeed, some CBA factors cannot be accurately measured or quantified. However, CBA is not intended for all quantifiable purposes, and other measures besides CBA should be used to support investment decisions in these areas.

This literature review examines scholarly articles, books, and other sources pertinent to CBA. It provides descriptions, concepts, and an evaluation of each source so that the reader may gain a better understanding of the theory that supports CBA effectiveness, the circumstances under which a CBA is effective, and just how it supports the making of investment decisions. It evaluates what should be estimated and the methodologies used to quantify the cost of benefits. This paper also discusses the accuracy and reliability of CBA and what techniques are available to support decision-making in the early phase of a program life-cycle. In establishing a perspective on the misunderstanding and misuse of CBAs, it addresses in particular issues of policy importance, cost estimation, and decision-making. This paper is intended to contribute to overall effectiveness in making key investment decisions using a CBA.

Opposing Viewpoints

In recent years, many analysts suggested that CBA was the preferred methodology for evaluating the economic factors associated with regulations and investment decisions (GAO, 2009). Even so, critics such as Kornhauser (2000) and Gillroy (1992) argued that a CBA does not identify proposed measures of benefits or such harms as death or accidents. Kornhauser's (2000) article describes and critiques CBA, discusses the justification for CBA from a legal, economic, and philosophical perspective, and focuses particularly on a CBA framework that relies on practices and not theory. For example, Kornhauser (2000) argues that CBA does not quantify life, the environment, or any other rare products or services. Kornhauser (2000) noted that Adler and Posner (1999) had adopted a similar approach in which they distinguish CBA as a moral criterion versus a decision-making process. From this argument, Kornhauser (2000) raised two concerns: that CBA inappropriately generates estimates for products and services, and that it produces inconsistent valuations of life.

Other authors rejected CBAs because of their level of uncertainty surrounding the accuracy and reliability of the analysis. For instance, Kornhauser (2000) showed that critics such as Anderson (1993) and Graham and Vaupel (1981) argued that CBA should provide cost data on economic policy, value, or risk but not life. These authors believe that the CBA cannot handle complex investment decisions. However, government agencies *are* complex institutions where many decisions are based on the results of a CBA. For example, the Department of Defense consistently develops CBAs as a framework to set forth objectives and fundamental trade-offs in assessing alternative solutions for economic risks, values, and moral conditions.

Kornhauser (2000) argues that it is inappropriate to consider the results of a CBA to be a moral criterion. For example, if the risk of death is conditional, based on medical treatment reducing the probability of death .001, and if the agent decides to pay $1,200,000 for treatment, then the willingness to pay produces a value to life of $1,200,000 (Kornhauser, 2000). Furthermore, if the agent decides not to pay for treatment, then the value of life should not be quantified. According to Kornhauser (2000), death has no measurable value – no amount of money that one can transfer to the agent after death will restore the pre-loss level of one life. CBA, then, should not be used to calculate death. There are others means of deriving the value of life.

Pursuing Programs and Policies

Although the critics' arguments are reasonable, they do not take into account that the federal government often requires that an independent CBA be conducted when key decisions affecting the public interest must be made. These decisions may be based on changes in regulations on the environment, health, education, and safety of this nation. For example, consider the economic value of some government programs, such as increasing the level of education or decreasing environmental regulations, even when precise values cannot be fully captured by referencing market behaviors or opinion polls (Hammitt & Treich, 2007). Instead, these values are estimated through CBA and other feasibility studies. Hammitt and Treich (2007) noted that since these studies need to consider the full scope of governmental programs in order to be holistic, it is vital that some consideration be given to the morality of the expected outcomes: ethical decisions or actions made by decision-makers. These expected outcomes can affect which viable alternative the decision-makers may choose in these public decisions. CBA will have significant validity both because it is mandated by law, and because it is tested for accuracy and creditability through-out the CBA process.

Today, CBA is used to report to Congress, the Office of Management and Budget (OMB), and the Office of Information and Regulatory Affairs in order to inform investment decisions that are economically significant. Although it is not always possible to quantify and convert to a dollar figure the costs and benefits associated with initiatives, even using techniques such as willingness to pay, CBA still provides an effective means of making investment decisions.

IN WHAT WAY CBA IS EFFECTIVE

The great effectiveness of CBA lies in its ability to provide increased understanding of the consequences of proposed public programs (Ergas, 2009). CBA must be understood as one means to aid decision-makers in making the best decisions for the public good (Ergas, 2009). The value of CBA will vary with the importance of mandates, policies, and regulations. For example, CBA offers a well-established and tested approach, supported by substantial research, for identifying and assessing the physical impacts of different investment options, in addition to estimating their economic value. This approach has been used to develop cost estimates for the most critical decisions this nation faces. These decisions are used to formulate social policy and budget appropriations for such programs as the War on Terrorism, Healthcare Reform, the Renewal Energy Act, the Race to the Top education initiative, and the American Recovery and Reinvestment Act. A CBA can enable decision-makers to make prioritized decisions about these programs. It provides a comprehensive view of the programs' costs and benefits, as well as other economic factors that are critical to the budget process. Most importantly, a CBA is measurable (Ergas, 2009).

CBA provides information on monetary intensity as well as on individuals' willingness to make the types of trade-offs implicit in many social investment decisions. According to Makowsky and Wagner (2009), this type of trade-off often involves exchanging money for social outcomes rather than for other goods and services. Chan (2004) pointed out that monetary results provided by CBA can be expected to contribute to the importance of public affairs by enabling better decisions. Monetary information provided by CBA constitutes a highly useful input into the process of balancing or trading-off among different types of objectives (Chan, 2004). For example, whenever there are program alternatives for investment decisions, the CBA increases the rationality of the decision-making process by providing better information concerning the consequences of these alternative choices (Chan, 2004). The core of any CBA is the actual measurement of the benefits and the cost of the alternatives being analyzed. Therefore, it is necessary to identify what is to be measured, the tools that will be used to measure it, and techniques that will be used to quantify the data.

CBA Tools and Techniques

CBA employs several tools for addressing uncertain outcomes and values, including sensitivity, probability, and break-even analysis (Makowsky & Wagner, 2009). Before government decision-makers decide upon a suitable CBA method (or combination of methods) for estimating the cost of social investment decisions, they must understand the context of the program (Joshi & Pant, 2008). The four commonly used methods for calculating CBA are the Engineering Estimate, Parametric Modeling, Analogy Estimating, and Delphi Method. However, in an engineering environment, only two of those are typically used – Parametric Modeling and Engineering Estimate. These two methods share a similar approach, are often used in tandem, and are commonly used for government estimating. In fact, the government's interest in parametric best practices strongly affects the commercial and in-house parametric models.

Engineering Estimate

The engineering estimate is the traditional method of developing cost estimates. This method uses a bottom-up approach that calculates cost and benefits at the lowest level of detail. This approach separates total products and services into individual components so that each unit is separate and distinct. The unit cost for each part in an engineering architecture is computed in order to arrive at a total material cost. A similar method is used for labor and other cost elements. For example, suppose a federal agency wanted to build a $500 million secure, high-bandwidth wireless IT infrastructure in response to changes in its mission needs. To develop the costs and benefits for this investment, a program life-cycle cost is developed using a work breakdown structure (WBS) to capture the scope and account for all cost activities. Each unit cost from the engineering architecture and from the resource plan is mapped to an activity in the WBS to develop the sum of all cost values. The costs and benefits are calculated to determine the Net Present Value (NPV) of the investment. NPV converts costs and benefits that occur over the program life-cycle to current year values. Upon completion of the bottom-up cost estimate, the values are used during proposal preparation and, subsequently, for making an investment decision.

Using the engineering estimating method has advantages and disadvantages. One advantage is that it provides a detailed basis for cost estimating. It can also be useful for tracking costs, since separate estimates are computed for each activity during each phase of the life-cycle. The life-cycle cost ranges from program conception to end-of-life and includes planning, design, development, testing, implementation, and maintenance costs. Engineering estimating considers government labor, contractors, hardware and software, infrastructure, security, and other direct and indirect costs associated with the program. Data are gathered through interviews, schedules, project plans, and existing budgets. Costs are usually identified from information provided by the sponsor and are often supplemented by assumptions made by the program team (Li & Napier, 2010). Consequently, an advantage of a CBA's bottom-up estimate is that both costs and benefits are in the same units of estimation as net benefits (benefits minus costs). This method is straightforward (Li & Napier, 2010). However, using this simple method in CBA produces a point estimate with no consideration of variation of costs or even ranges around the point estimate (Li & Napier, 2010).

Parametric Modeling

Parametric modeling is a top-down costing approach that uses statistical relationships relying on historical data. Here, the "estimate is achieved based on experience, using findings from past products and estimating the expected cost" (Newnes et al., 2008, p. 102). Parametric estimates are produced using mathematical relationships between a cost driver (independent variable) and the program cost (dependent variable), based on several historical programs. By and large, commercial estimating tools are parametric estimates, but a parametric model can also be produced in-house if historical information is available for several programs. Regression analysis is used in building a parametric model that looks for significant cost-estimating relationships. Many parametric models also generate insight into the uncertainties and risks associated with program costs and schedules. This is critical, given the enormous complexity of many modern programs. Uncertainties and risks may cause profound changes. A model that deals with uncertainty and risk will provide a range estimate (a probability distribution) that gives some idea of the possible array of cost or schedule outcomes and the relative likelihood of particular outcomes identified as risks. Range estimates describe all risks that can impact the achievement of projected benefits or the cost of solving the most complex business problem. In parametric cost modeling, each risk has an associated mitigation strategy and an assessment of likelihood of occurrence (Serpell, 2004).

Risk evaluation is a deliberate, systematic "process aimed at identifying program risks and developing strategies to either reduce them or take steps to avoid them altogether" (Abi-Karam, 2006, p. 45). The most common approach to account for risks in cost estimation is to include a fixed contingency to the cost estimate (Li & Napier, 2010). For example, if the estimate for a program is $20 billion, and the federal government has a policy of adding 10% contingency for this type of program, the final cost estimate for the program will be $22 billion (Li & Napier, 2010). Advantages of parametric models include being dynamic and easy to use, with less detailed information. On the other hand, commercial products might be chosen based on limited insight into the underlying model and inherent mathematical calculations. Without proper calibration and crosschecks of the cost models' outputs, the cost estimator lacks responsibility for the estimates produced. According to Li and Napier (2010), CBA must address estimating methods, relationships, and data sources; treat sensitivity, risk, and uncertainty of key cost drivers and assumptions; and address all quantifiable benefits as well as any non-quantifiable benefits influencing the recommended course of action. They also argued that errors in estimates from an early life-cycle phase will improve over time as information becomes readily available.

Accuracy and Reliability

The most significant factor influencing cost estimates is accuracy in the early phase of the program life-cycle. With a weighted average of nearly 40 percent, this low accuracy rate has a large part to do with the amount of information available about the program during the early phase of the program life-cycle (Ciraci & Polat, 2009). Accuracy is defined "as nearness to truth" (Serpell, 2004, p. 159). Reliability as a measurement, on the other hand, refers to knowing how well and consistently the measuring instrument measures the true value of the characteristic (Serpell, 2004). As cited by Flyvbjerg, Skamris Holm, and Buhl (2005), studies report "inaccuracy in cost estimation from 20.4% to 44.7% depending on the type of [program]" (Li & Napier, 2010, p. 95).

Similarly, as cited by Bruzelius, Flyvbjerg, and Rothengatter (2002), it has been "reported that overruns of 50% to100% in fixed prices are common for crucial infrastructure [programs], and overruns above 100% are 'not uncommon', with the magnitude of cost overrun unchanged over the past 70 years" (Li & Napier, 2010, p. 95). Serpell (2004) points out that conceptual cost estimates are critical inputs for decision-making in the early phase of a program. Serpell (2004) addresses the problem of quality of conceptual estimating. He proposes a model based on existing knowledge that can be used to develop an assessment system for cost estimation (Serpell, 2004). Nonetheless, detailed information is required for costing, and it may be difficult to predict the accuracy and reliability in certain circumstances, especially during the early phases of the life cycle when detailed information is often unavailable.

Programs may consider a way to measure accuracy and reliability using statistical analysis to determine the sampling errors and confidence intervals of a CBA. For example, a quality model that is used to obtain an appropriate initial assessment of the expected accuracy and reliability of a cost estimate may consider the true value indicators and predictors that compute preciseness of the estimate. Practitioners may also focus on aligning cost to strategy, capabilities, performance measure, and outcomes in order to help improve cost estimates' accuracy and reliability. Serpell (2004) suggested that by using information from a cost estimate, a qualitative causal model can be constructed as a means to assess accuracy and reliability. An "assessment process is designed to evaluate the quality of an estimate by providing a quantitative reasoning approach" to a cost model (Serpell, 2004, p. 157). The expected accuracy and its associated reliability enable decision-makers to analyze different possible alternatives (Serpell, 2004) while knowing the level of validity in the data. This information helps establish cost contingencies on a solid basis and helps manage uncertainty. These contingencies can be used in conjunction with the parametric modeling in cost estimation in order to further improve the accuracy of the analysis.

There are advantages and disadvantages to these statistical models that measure accuracy and reliability. One advantage is that they tend to be more objective and assign causals to cost elements. However, the process requires that the data be already available, although, in practice, most organizations do not keep adequate estimating records on hand. Program resources such as analysts, programmers, and IT project support can apply their expert knowledge and experience to estimate the cost of programs. They can assess the differences between past and future programs and are especially useful for new or unique programs for which no historical precedent exists.

CBA DECISION-MAKING

Elected politicians, non-elected officials, and lobbyists for interest groups have participated in the elevation of CBA, even though some have opposed it (Makowsky & Wagner, 2009). These decision-makers face difficult choices in determining how best to allocate resources across defense programs, social programs, and services based on the outcomes of the CBA. Users can differ in what they are seeking to accomplish with a CBA, and their participation does not imply support for all the uses to which a CBA can be used. For instance, many analysts were involved in the generation of CBA who, nonetheless, objected to some features of it (Makowsky & Wagner, 2009), including economic analysis, alternative analysis, and independent cost estimates. However, CBA does provide useful information for these decisions by indicating the extent to which the values that individuals place on program outcomes are likely to exceed program costs. Determining these values has always been challenging. Despite these challenges, decision-makers with factual information from the CBA must be convinced that this analysis is a positive, effective, and descriptive exercise that supports the mission, strategies, and goals of the federal agency.

Most social programs, on the other hand, lead to outcomes for which no fair value exists, such as improved health, safety, or environmental quality. Instead, these fair values must be estimated from a moral and ethical point of view by asking individuals about their willingness to pay. "Maximization of the numbers of lives saved or the maximization of quality adjusted life years (QALY), for example, have been … used in some public policy decisions over CBA" (Kornhauser, 2000, p. 14). CBA is intended to help decision-makers to clarify areas of agreement and disagreement, separating data from assumptions and allowing those who disagree to test the effects of alternative analysis. CBA is a strategic management tool that allows decision-making about the effectiveness and efficiency of an agency's current and future plan of operations. For example, an agency in the process of making a major investment decision about an integrated solution that would prepare it for the 21st century would by directed by the federal government to complete a CBA to justify the investment decision. Upon completion of the CBA, the agency would use this study to quantify the costs and benefits, decide on a plan of action, and submit a request for funding that would support this decision. As can be seen in this example, CBA provides many sources of information to decision-makers and public administrators. It helps public administrators understand how to evaluate complex solutions, provide consistency in their analysis, and facilitate comparison across program alternatives. From a decision-makers' perspective, CBA provides benefits expressed in discounted dollars, constant dollars, or economies of scale. These benefits are usually stated in terms of achieving an agency's mission, goals, or objectives.

There are many programs giving evidence of the effectiveness of a CBA as shown in this paper. An effective CBA encourages open inquiry and debate between decision-makers and public administrators. These public administrators are responsible for enacting most of the program changes. They are tasked with achieving agency missions and providing public service in political environments (DeForest MoIina, 2009). Undoubtedly, CBA provides the economic data to help produce better investment decisions that are debated between decision-makers and public administrators (Niels & Van Dijk, 2000). It allows for program evaluation and lessons to be learned for future actions. For example, when decision-makers are setting policy, funding programs, and enforcing priorities by enlarging the array of program options and solutions that are available in the policy process, CBA assists in understanding the ramifications of these decisions through prior lessons learned. In other words, an effective CBA is a viable tool for supporting decision-making about some of the nation's most challenging issues, such as foreign policy, economics, the war on terrorism, health care, energy, and education. CBA can be a force for increased accountability and transparency in the decision-making process. Among all its uses, CBA's greatest effectiveness lies in its ability to provide increased understanding of the consequences of proposed public policies.

CONCLUSION

The purpose of this paper was to identify the effectiveness of CBA within federal government in order to ensure that there are viable alternatives in making investment decisions. The critics who argue that CBA is incorrectly used generally misunderstand its role. It provides one critical input into the decision-making process. Another group argues that the use of CBA is often inappropriate in the areas of safety, health, and environmental regulations. As indicated in this study, however, CBA has been shown to be the preferred methodology for evaluating the economic factors associated with regulations and investment decisions. Practitioners of CBA for government agencies rely on the effectiveness of an estimate in the early stages of the program life-cycle to ensure that there are viable alternatives in making investment decisions. Therefore, it is important that each of the elements used in making important decisions, including CBA, all work effectively and efficiently together so that decision-makers can make the most informed decisions.

The results of this study suggest that if a CBA is performed correctly, public administrators who are responsible for implementing programs may request funding, develop budgets, identify risks, and manage programs' performance based on the values computed from the analysis. It is critical that public administrators remember that a CBA done early in the program is more likely to be less accurate, simply because needed data do not yet exist. For a CBA to be truly valuable for a program, it should be updated periodically during the program's life-cycle as additional information regarding the program implementation is realized. CBA furnishes helpful information to the decision-makers to aid them in making effective investment decisions. Nonetheless, it is not always possible to quantify and convert intangibles into costs and benefits associated with these investment decisions. Therefore, future studies may consider how to convert intangible costs and benefits, such as strategies, capabilities, or performance measures into more defined tangible costs and benefits so that economic estimates computing net present values are even more accurate and reliable in making sound investment decisions. This contribution will better serve MITRE's federal government sponsors.

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