5 FAH-5 H-620
BENEFIT-COST ANALYSIS (BCA) PROCESS

(TL:ITS-1; 02-13-2002)

5 FAH-5 H-621 ANALYST'S PERSPECTIVE

(TL:ITS-1; 02-13-2002)

a. The analyst preparing the BCA must follow the 11 structured steps below designed to evaluate proposed alternatives. The steps are as follows:

(a) Step 1—Determine and/or define project objectives;

(b) Step 2—Document current process;

(c) Step 3—Estimate future requirements;

(d) Step 4—Collect cost data;

(e) Step 5—Choose at least three alternatives;

(f) Step 6—Document BCA assumptions;

(g) Step 7—Estimate costs;

(h) Step 8—Estimate benefits;

(i) Step 9—Discount costs and benefits;

(j) Step 10—Evaluate alternatives; and

(k) Step 11—Perform sensitivity analysis.

b. The following guidelines describe these steps in detail and explain the techniques to use in the BCA process. Keep in mind that the BCA effort must be tailored to the size of the project. The examples provided herein come from a variety of sources and do not relate to one specific project.

c. The BCA systematically compares alternative ways of meeting specific objective. It analyzes and compares costs, benefits, and uncertainties to determine the most cost effective and beneficial means to satisfy the objective, regardless of the size of the project. The information collected, processed, and presented in the 11 steps varies according to the size of the project. All BCAs must incorporate the following four basic principles:

(1) Include alternatives that are operationally and technically feasible to satisfy objectives;

(2) Consider both current and future costs and benefits;

(3) Consider not only the costs associated with each alternative but also when the costs will occur. Do this by expressing costs (and benefits) in present value terms; and

(4) Compare alternatives.

5 FAH-5 H-621.1 Step 1—Determine and/or Define Project Objectives

(TL:ITS-1; 02-13-2002)

a. The BCA should include the project objectives and other pertinent background information so that it stands on its own and can be understood by a reviewer who is not intimately familiar with the organization and its work process. The objectives should be designed to improve the work process so the Department of State can better perform its mission.

b. Need is the foundation of the BCA. State the need in clear and concise terms; the remainder of the BCA process is based on this statement.

c. Although it is important for the reader to understand the project objectives, the crucial issue is that the project manager and management understand what it is they are trying to accomplish.

d. In some environments, a BCA may be initiated when management has only generally defined the problem. When that occurs, the time and effort required to complete the BCA, would be increased significantly.

5 FAH-5 H-621.2 Step 2—Document Current Process

(TL:ITS-1; 02-13-2002)

Everyone involved in the preparation and review of the BCA needs to understand the current process because it is the baseline for nearly all decisions regarding new alternatives. Therefore, the current process must be thoroughly documented. The areas to be addressed are:

(1) Customer services; and

(2) System capabilities, technical architecture, and system costs.

The current documentation should be revised if it does not address these areas, or does not reflect the current environment. If no environment is available, it will have to be created.

5 FAH-5 H-621.2-1 Customer Service

(TL:ITS-1; 02-13-2002)

a. Because every process or IT system provides services to customers, each customer's relationship with the processing organization should be clearly documented.

b. While this information provides the basis for identifying benefits, most IT system and operational procedures do not explain how the services provided to customers help them perform their function faster and/or better. That question is addressed in 5 FAH-5 H-621.8 Step 8—Estimate Benefits.

5 FAH-5 H-621.2-2 System Capabilities

(TL:ITS-1; 02-13-2002)

System capabilities are the resources required for providing peak demand customer service. Some examples of system capabilities are:

(1) 100 megabytes of disk storage space;

(2) Help Desk personnel to support 50 users; and

(3) On-line access to 100 users.

5 FAH-5 H-621.2-3 System Architecture

(TL:ITS-1; 02-13-2002)

The system architecture includes the hardware, software, and communication links as well as the physical facilities required for systems operations. The documentation should go beyond a simple inventory to include other information necessary for determining systems costs and evaluating the future utility of individual items. The documentation should indicate whether items are owned or leased by the U.S. Government, or owned or leased by a contractor.

(1) For hardware, the following information is desirable:

(a) Manufacturer;

(b) Make;

(c) Model;

(d) Year;

(e) Cost;

(f) Expected life;

(g) Upgradability;

(h) Power requirements;

(i) Maintenance requirements; and

(j) Operating systems supported.

(2) For software, the following information is desirable:

(a) Manufacturer;

(b) Name;

(c) Version number;

(d) Year acquired;

(e) License term;

(f) Hardware requirements; and

(g) Cost (annual or purchase).

(3) For physical facilities, the following information is desirable:

(a) Location (address, room number);

(b) Size (number of square feet);

(c) Capacity (number of machines or people);

(d) Type of structure (office, storage);

(e) Availability (how long is it guaranteed?); and

(f) Annual cost.

5 FAH-5 H-621.2-4 System Costs

(TL:ITS-1; 02-13-2002)

The cost of the current system provides the baseline. The benefit cost analysis must include all elements. The cost element table in 5 FAH-5 Exhibit H-621.2-4 addresses many of the cost elements for most systems. More detailed information on costs are addressed in Step 7. A particular system may not include all elements identified within a particular category and may include some activities not shown.

5 FAH-5 H-621.3 Step 3—Estimate Future Requirements

(TL:ITS-1; 02-13-2002)

Future customer requirements determine the system capabilities and architecture, and ultimately affect system costs and benefits. Thus, it is important to accurately estimate the future requirements. The two important items to consider are the system life cycle and the peak life cycle demands.

5 FAH-5 H-621.3-1 Determine Life Cycle Time

(TL:ITS-1; 02-13-2002)

a. The first step is to determine how far into the future to plan. This period is called the life cycle cost horizon or the system life cycle. The period for the analyses of IT projects should cover the system life cycle. For this guidance, the system life cycle includes the following activities:

(1) Initiation;

(2) Design;

(3) Acquisition;

(4) Implementation;

(5) Operations; and

(6) Maintenance.

b. A system life cycle ends when the system is terminated or is replaced by a system with significant changes in processing, operational capabilities, resource requirements, or system outputs. Some of the factors to consider are the speed of hardware and software changes, the probability of major changes in system requirements, and the estimated costs of maintaining the system. Large, complex systems should have a life cycle of at least five years, and the maximum length of time for a BCA should normally be no more than 10 to 12 years. The system life cycle model (SLCM) presented in the Managing State Projects (MSP) methodology and 5 FAM 600 provides a structured framework for developing information systems. The BCA is an integral part of this framework that first begins in the initiation phase of the cycle. The table in 5 FAH-5 Exhibit H-621.3-1, System Life Cycle Management, shows the purpose for the BCA during the various phases.

5 FAH-5 H-621.3-2 Estimate Life-Cycle Demands

(TL:ITS-1; 02-13-2002)

a. The first step in estimating the user demands over the system life cycle is to determine the best measures of the demand. Use those measures to determine what the demands were for several proceeding years, calculate the change in demand from year to year, average this change, and use the average to make the predictions. For example, if you have averaged an increase in demand of 10 percent per year over the last five years, assume that this trend will continue, and demand will increase by 10 percent every year over the life cycle of the study. The example in 5 FAH-5 Exhibit H-621.3-2, Average Annual Increase, uses one measure, and demonstrates a 10% average for the past four years.

b. The danger of this approach is that past history is not always a high-quality indicator of the future. The mainframe computer centers that assumed mainframe usage would continue to increase in the 80s at the same rate as the 70s were not prepared for the PC explosion. Use this method when external factors have been evaluated to confirm that the past should be good indicator of the future. Consult staff members who have been involved with the current system operation for a significant period of time.

c. A second method to determine life-cycle demands is to survey your customers. The advantage to the survey method is that it can identify major changes in customer requirements. Another possible outcome to a survey is that you will find that your customers have problems for which there is an IT solution. These “value added” solutions should be noted and quantified for inclusion under benefits. Surveying your customers properly requires time and expertise. Surveys must be prepared and evaluated with extreme care to ensure that the results are interpreted properly.

5 FAH-5 H-621.3-3 Other Considerations

(TL:ITS-1; 02-13-2002)

a. If possible, make more than one forecast using different estimating methods. This will serve as a “sanity check” for the original forecast and add validity to the overall estimate.

b. Include averages and peak demands in your estimates. If the system is not designed to meet peak demands, there must be a good reason (usually cost) not to do so.

c. Use professional experience to temper the results of any forecast. Do not ignore this experience about future demands and technology trends. Experience will enable you to identify and explore local IT issues and trends.

d. Get comments from other IT professionals on your estimates. Other analysts can point out potential shortcomings in the estimates or provide confirmation of methods and results.

e. Try for an estimating range in addition to the point estimate. The point estimate is the basis for developing your alternative systems, but the high and low values are important for the sensitivity analysis.

f. Document everything. Good documentation backs up your estimates, thus minimizing uncertainty during reviews. The documentation will also facilitate the (inevitable) updates to the estimate.

5 FAH-5 H-621.4 Step 4—Collect Cost Data

(TL:ITS-1; 02-13-2002)

Cost data must be collected to estimate the cost and benefits of each project alternative. Six sources of data are:

(1) Historical organization experience;

(2) Current system costs;

(3) Market research;

(4) Publications;

(5) Analyst judgement; and

(6) Special studies.

This is one of the most difficult steps in a BCA, but also one of the most important; the quality of your analysis is only as good as the quality of the cost data.

5 FAH-5 H-621.4-1 Historical Organization Data

(TL:ITS-1; 02-13-2002)

Historical contract data for an organization can be used to estimate the future purchase prices of hardware, software, and services. If contracts were used to provide system support in the past, they can give you the costs for leasing and purchasing hardware and hourly rate contractor personnel. Contracts for system support services for other systems in your organizations or other ICs can provide comparable cost data for the development and operation of a new system. The numbers will probably need to be adjusted to account for differing quantities and qualities for the proposed system. If necessary, adjust the cost to reflect current year price levels. Document all adjustments for future reference.

5 FAH-5 H-621.4-2 Current System Costs

(TL:ITS-1; 02-13-2002)

The cost of your current computer system can be used to price similar alternatives. A study performed by the Department of Housing and Urban Development (HUD) before their decision to outsource IT functions, for example, assumed percentage increases and decreases from their current system when estimating different alternatives. Cost elements were addressed in 5 FAH-5 H-621.2-4 and will be addressed in more detail in Step 7.

5 FAH-5 H-621.4-3 Market Research

(TL:ITS-1; 02-13-2002)

a. Contact several sources to provide cost estimates for computer hardware, software, networks, user support, outsourcing, etc. Prepare clear, detailed performance requirements to be the basis for the estimates. Quotes from multiple sources (if possible) will provide an average figure that should be a realistic price. Check the technical content and scope of the quotes: low estimates may be omitting some necessary (and costly) services. Also, remember that a vendor's quote is not usually prepared with the same level of effort as a bid on a contract.

b. Vendors are usually happy to provide cost information because it gives them an opportunity to market their services. Be sure to let them know you are only looking for generic cost data for planning and analysis purposes, and that no procurement is planned at the present time. Organizations such as the Gartner Group and IDC Government can also provide assistance in developing costs data.

c. The Government-wide agency contracts (GWACS) are also good sources of current cost data for personnel, hardware, and software.

5 FAH-5 H-621.4-4 Publications

(TL:ITS-1; 02-13-2002)

Trade journals and industry publications are good sources of cost data. Trade journals usually conduct annual surveys that provide general cost data for IT personnel. Included in this category are government sources such as the General Services Administration (GSA) pricing schedule. The supplement to the Office of Management (OMB) Circular A-76 provides inflation rates and tax rates.

5 FAH-5 H-621.4-5 Analyst Judgment

(TL:ITS-1; 02-13-2002)

a. In some cases, data may not be available to provide an adequate cost estimate. In that situation, the best alternative is to use the judgment and experience of BCA team members to estimate costs. To provide a check against the team's estimates, discuss them with other IT professionals, both the government and industry. These discussions can highlight the strengths and weaknesses of the estimating logic and provide alternative estimates for comparison. Detailed documentation is important, because it will facilitate your discussion with others and renders a history for later verification and validation.

b. Analyst judgment is also a legitimate tool for evaluating costs obtained through other means. The team's experience and knowledge must ensure that data gathered from other sources is applicable to the cost being estimated, and that the data is applied correctly.

5 FAH-5 H-621.4-6 Special Studies

(TL:ITS-1; 02-13-2002)

Special studies are sometimes done to collect cost data for large IT projects. For example, the State Department, which outsources its data centers, used three different in-house studies to provide costs for software conversion, internal operations, and potential benefits. These data sources became the foundation of the State Department's benefit-cost analysis. While the number and scope of the studies may seem excessive, the Department was trying to gather as much information as possible before deciding how to spend hundreds of millions on automated data processing. Such studies are not feasible for a quick analysis, but should be considered before committing to outsourcing or other large, mission-critical projects.

5 FAH-5 H-621.5 Step 5—Choose at Least Three Alternatives

(TL:ITS-1; 02-13-2002)

a. A BCA must normally present at least three alternatives. One alternative that should always be included in the BCA is to continue with no change. During the work process evaluation, a number of alternatives may be considered. Other alternatives are whether to do development, operations, and maintenance with in-house personnel or contractors. Each technical approach that is a viable alternative from a work process perspective should be included as an alternative. However, the number of technical approaches may be limited if only one or two are compatible with

the State Department architecture. Some alternatives can be addressed and rejected because they are not feasible for reasons other than costs and benefits.

b. Management has probably decided that the no change alternative is unacceptable, or you would not be looking at other alternatives; however, the costs and benefits of that alternative may not have been documented. Included that alternative should be proof that it is not the best alternative. If there are other factors that make the no change alternative unacceptable, that can be documented, and it would not be necessary to compare its cost and benefits against the feasible alternatives.

c. During the early stages of an IT project, there are many alternatives to be considered. This is particularly true during the work process evaluation. If the work process is operating in a manner that makes maximum use of IT to maximize its efficiency and effectiveness, the process may not need to be changed. If the process can be changed to take advantage of IT, there may be two or more alternatives that appear to be feasible. If so, they may be alternatives that should be included in the BCA. Either the development, operations and maintenance can be done with in-house personnel or with contractors, providing several potentially, competing alternatives. If the decisions to use in-house resources are not available, then only one alternative may be feasible for the BCA. If that is the case, it should be documented.

d. When considering the potential use of contractors, it should be noted that, technically, a decision to contract out a specific function must be made following the guidelines in OMB Circular No. A-76, Performance of Commercial Activities**.** Using a contractor to develop, maintain or operate an IT system does not normally require an A-76 study, but the circular does not contain guidance on determining in-house costs that would be pertinent to a BCA alternative.

e. Any IT projects that involve acquiring equipment should consider the alternatives of leasing and purchasing. With the rapid changes in technology, the useful life of desktop PCs has been reduced to less than 5 years. OMB Circular A-94, Section 13 specifically addresses lease-purchase analysis.

5 FAH-5 H-621.6 Step 6—Document BCA Assumptions

(TL:ITS-1; 02-13-2002)

a. Because a BCA frequently relies on many assumptions, it is important to document all of them, and, if possible, justify them on the basis of prior experiences or actual data. For example, you may assume that the PC hardware and software for a system will need to be upgraded every three years. This could be justified based on the rapid increases in capacity, speed, and decreases in cost for PCs over the past 15 years.

b. This can also be an opportunity to explain why some alternatives were not included in the analysis. Alternatives that are eliminated in the early stages of a BCA because of an assumption must be clearly explained and justified.

5 FAH-5 H-621.7 Step 7—Estimate Costs

(TL:ITS-1; 02-13-2002)

Many factors must be considered during the process of estimating the costs associated with competing alternatives in a BCA. All costs for the full system life cycle for each competing alternative must be included. The following factors must be addressed:

(1) Activities and resources;

(2) Cost categories;

(3) Personnel costs;

(4) Indirect costs;

(5) Depreciation; and

(6) Annual costs.

5 FAH-5 H-621.7-1 Activities and Resources

(TL:ITS-1; 02-13-2002)

a. Identify and estimate the costs associated with the initiation, design development, operation, and maintenance of an IT system. One approach is to identify the activities performed and estimate the cost of the resources associated with each activity. The activities identified below (or comparable activities that are part of the system life cycle) should be addressed.

(1) Problem definition;

(2) Work process evaluation;

(3) Processing requirements definition;

(4) Security planning;

(5) IT performance measure development;

(6) Benefit cost analysis;

(7) IT investment review;

(8) IT resources acquisition;

(9) System implementation; and

(a) Design;

(b) Development;

(c) Operation;

(d) Maintenance; and

(10) System performance evaluation.

b. A sample list of activities and the required resources (cost elements) is provided in 5 FAH-5 Exhibit H-621.7-1.

5 FAH-5 H-621.7-2 Cost Categories

(TL:ITS-1; 02-13-2002)

Costs should be identified in a way that relates to the budget and accounting processes.

5 FAH-5 H-621.7-3 Indirect Costs

(TL:ITS-1; 02-13-2002)

Direct costs, such as direct labor and direct material, are costs incurred in a process that is "hands on," that directly produces the output. Indirect costs (often referred to as overhead costs) are incurred in a support role (all costs that are not direct). Typical overhead items are indirect labor, indirect material, and fixed costs such as rent, depreciation, advertising, taxes, utilities and insurance. Overhead is often expressed as a percentage of direct labor.

5 FAH-5 H-621.7-4 Depreciation

(TL:ITS-1; 02-13-2002)

Depreciation is defined as lowering the estimated value (referred to as book value) of a capital asset (usually only those items valued at $5,000 or more). Depreciation is also defined as the method used to spread the cost of tangible capital assets over an asset's useful life (the number of years it functions as designed). It is computed by comparing the original cost (or value) with the estimated value when it can no longer perform the function(s) for which it was designed, its residual or salvage value. There are a number of ways to compute depreciation, but OMB prefers that straight-line depreciation be used for capital assets. 5 FAH-5 Exhibit H-621.7-4,Tangible Asset Depreciation, illustrates straight-line depreciation of a $10,000 asset with a useful life of 5 years, and a residual or salvage value of $1,000. The computation includes the following steps:

(1) Subtract the residual value from the book value to get the depreciation amount ($10,000 - $1,000 = $9,000);

(2) Divide depreciation amount by the useful life to compute annual depreciation amount ($9,000/5 years = $1,800/year); and

(3) The book value at the end of each year is computed by subtracting the annual depreciation from the book value at the beginning of the year. For example, the book value at the end of Year 1 is $8,200 ($10,000-$1,800). See 5 FAH-5 Exhibit H-621.7-4, Tangible Asset Depreciation.

5 FAH-5 H-621.8 Step 8—Estimate Benefits

(TL:ITS-1; 02-13-2002)

Identifying and estimating the value of benefits will probably be the most difficult task in the BCA process. Six specific activities are addressed in this section.

5 FAH-5 H-621.8-1 Define Benefits

(TL:ITS-1; 02-13-2002)

Benefits are the services, capabilities, and qualities of each alternative system, and can be viewed as the return from an investment. Webster uses such terms as advantage, useful aid, help, and service to define it. Some examples of benefits for IT systems are:

(1) **Accuracy—**Will the proposed system provide better accuracy by reducing the number of data entry errors or eliminate some data entry that would, in turn, result in fewer data entry errors?

(2) **Availability—**How long will it take to develop and implement the system? Will one alternative be available sooner than another will?

(3) **Compatibility—**How compatible is the proposed alternative with existing facilities and procedures? Will one alternative require less training of personnel or less new equipment or software?

(4) **Efficiency—**Will one alternative provide faster or more accurate processing of inputs? Will one alternative require fewer resources for the processing?

(5) **Maintainability—**Will the maintenance costs for one alternative be less than the others? Are the maintenance resources easier to acquire for one alternative? An example of this would be availability and cost of programmers to maintain the software.

(6) **Modularity—**Will the software for one alternative be more modular than the other alternatives? Greater modularity can reduce maintenance costs and may increase the portability of the software.

(7) **Reliability—**Does one alternative provide greater hardware or software reliability? Greater reliability translates to higher productivity in using and/or operating the system and less time for operations and user support.

(8) Security—Does one alternative provide better security to prevent fraud, waste or abuse? Are privacy, confidentiality, and data integrity enhanced?

5 FAH-5 H-621.8-2 Identify Benefits

(TL:ITS-1; 02-13-2002)

a. Every proposed IT system for an organization should have identifiable benefits for both the organization and its customers. Identifying these benefits will usually require an understanding of the work processes of the organization and its customers. Normally, the benefits to the customers will be much less than the benefits for the organization that is developing the system.

b. Some benefits for the provider organization could include flexibility, organizational strategy, risk management and control, organizational changes and staffing impacts. New IT systems may allow some personnel to perform two different jobs with little or no extra training; the new system may allow organizational changes that reduce the number of managers; or the new system may allow some jobs to be eliminated entirely. These benefits are often measured in terms of productivity gains, staffing reductions, and improved organizational effectiveness.

c. Possible benefits to customers include improvements to the current services and the addition of new services. These benefits can be measured in terms of productivity gains and cost savings, but the customers must be the ones to identify and determine how to measure and evaluate the benefits. Customer surveys are often needed to identify these benefits. At a minimum, the customers should be interviewed to identify the potential impacts of new or modified systems.

d. Many of the benefits discussed here are general and, in actual practice, will need to be defined more precisely. For example, the benefits of greater accuracy may be defined as have reduced personnel costs for data entry, error detection, and correction of errors.

5 FAH-5 H-621.8-3 Establish Measurement Criteria

(TL:ITS-1; 02-13-2002)

a. Establishing measurement criteria for benefits is crucial because of the Government Performance and Results Act (GPRA) and the Information Technology Management Reform Act (ITMRA). Both of these Acts emphasize having tangible measures of success (benefits) that are related to the overall mission and goals of the organization.

b. Establishing performance measures is a difficult task, especially for an activity that is in the planning stage. Fortunately, most IT systems have similar systems that can be used as guides for measuring benefits.

5 FAH-5 H-621.8-4 Classify Benefits

(TL:ITS-1; 02-13-2002)

Benefits that are "capable of being appraised at an actual or approximate value" are called **tangible benefits.** Benefits that cannot be assigned a dollar value are called **intangible benefits.** A good example of a tangible benefit is lower hardware costs; it is the difference between two-dollar values for hardware, by subtracting the cost of hardware for the proposed system ($100,000) from the cost of the current system hardware ($150,000). An example of an intangible benefit is flexibility. A proposed system may allow a manager to have two or three different people perform the same job without significant training expense. This could keep a system operational if one or more employees were out of the office for a period, but it would be impossible to assign a realistic dollar value to that capability. The value would depend on the impact of a portion of a system being inoperable for a period of time, the length of that time period, and the frequency which that situation occurs.

5 FAH-5 H-621.8-5 Estimate Tangible Benefits

(TL:ITS-1; 02-13-2002)

a. The process of estimating the dollar value of a benefit is similar to the cost estimation process discussed in the previous section. The dollar value of benefits can be estimated by determining the fair market value of the benefits. These dollar values are then assigned to the year in which the benefits will occur. If a benefit cannot be associated with a particular year, and that benefit is expected to be realized over the life cycle of the study, you may allocate the dollar value of the benefit equally to each year of the study. The benefit value may also be assigned to specific years with different values for each year.

b. Market research quotes can also be useful in determining benefit value. An important economic principle used in estimating public benefits is the market value concept. Market value is the price that a private sector organization would pay to purchase a product or service. When valuing new services that an upgraded IT system could provide, it may be useful to determine how much a company would charge to provide such a service. When increased productivity or reductions in personnel are the projected benefits, the value of the personnel time can be computed just as systems costs for personnel are computed.

5 FAH-5 H-621.8-6 Quantify Intangible Benefits

(TL:ITS-1; 02-13-2002)

a. Intangible benefits can be quantified using a subjective, qualitative rating system. A typical qualitative rating system might evaluate potential benefits against the following five criteria:

(1) Provides maximum benefits (2 points);

(2) Provides some benefits (1 point);

(3) Provides no benefits (0 points);

(4) Provides some negative benefits (-1 point); and

(5) Provides maximum negative benefits (-2 points).

b. Other scales use three or four evaluation criteria, and make no provision for negative benefits. The rating criteria can be used to enable numerical comparisons between alternatives. For the above criteria, another possible scale would be 10, 5, 0, -5, -10 instead of 2, 1, 0, -1, and -2.

c. Once the rating system is selected, each benefit is evaluated for each of the alternatives. This should be done by a group of individuals familiar with the current IT system and the alternatives being evaluated. Having five people do the evaluation would be ideal, and three evaluators should be a bare minimum. A large sample will "average out" individual preferences and perceptions. The numerical values assigned to the ratings then can be summed and averaged to obtain a score for each benefit. See 5 FAH-5 Exhibit H-621.8-6(1), *Quantify Intangible Benefits*, for scores for Benefits A—E from four reviewers using a scale of 1 to 5.

d. An option that can be used in a qualitative assessment is to "weight" each of the benefit criteria according to importance. The more important the benefit, the higher the weight. The advantage of weighting is that the more important benefits have a greater influence on the outcome of the benefit analysis. The weighting scale can vary between any two predetermined high and low weights. For an example of calculating a

weighted score, look again at 5 FAH-5 Exhibit H-621.8-6(2), *Weighted Scoring,* which shows the scores for benefits A through G for two alternatives of a BCA and demonstrates that the use of weighting factors makes alternative 1 the clear winner.

5 FAH-5 H-621.9 Step 9—Discount Costs and Benefits

(TL:ITS-1; 02-13-2002)

a. After the costs and benefits for each year of the system life cycle have been identified, convert them to a common unit of measurement for comparing competing alternatives. This is accomplished by discounting future dollar values, thus transforming future benefits and cost to their "present value" (also referred to as the discounted value), which is calculated with the following formula:

P=F (1/(1+I) n)
Where P = Present Value; F = Future Value; I = Interest Rate; and n = number of years.

b. The term discount factor is used for (1/(1+I) n). Present values can be calculated by multiplying the future value times the discount factor instead of using the entire formula. The discount factors are published in the OMB Circular A-94, and include the discount factors from 1 to 30 years for discounting at the beginning of the year, the end of the year, and the middle of the year. The formula 1/(1+I) n is used when the assumption is costs and benefits occurring at lump sums at year end. The formula for the mid-year discount factor is 1/(1+I) n-5. The formula for the discount factor and/or rate when costs and benefits occur as lump sums at the beginning of the year is 1/(1+I) n-1.

c. See 5 FAH-5 Exhibit H-621.9, Discounted Costs and Benefits, for the annual costs and benefits for the life cycle of a system, along with the discount factor, the discounted costs and benefits (present values). The discounted costs and benefits are computed by multiplying the costs and benefits by the discount factor. Since costs and benefits often occur in a steady stream; mid-year discount factors are used. The net benefit without discounting is $380,000*$3,200,000 - $2,800.00, while the discounted (present value) net is less than $60,000 because the biggest costs are incurred in the first two years, while the benefits are not accrued until the third year.

5 FAH-5 H-621.10 Step 10—Evaluate Alternatives

(TL:ITS-1; 02-13-2002)

While most costs can be quantified in dollar terms, many benefits cannot. As a result, evaluating alternatives cannot always be done using present values of the costs and benefits; however, valid evaluations can still be made using a combination of dollar values and quantified relative values.

(Values are numeric but do not represent dollar values).

5 FAH-5 H-621.10-1 Evaluate with all Dollar Values

(TL:ITS-1; 02-13-2002)

a. When all of the costs and benefits for each competing alternative have been assigned dollar values and discounted, the net present value of the alternatives should be compared and ranked. When the alternative with the lowest discounted cost provides the highest discounted benefit, it is the clear winner, as shown in 5 FAH-5 Exhibit H-621.10-1(1), A Clear Winner.

b. There will probably be few cases where the alternative with the lowest discounted cost provides the highest discounted benefit. The next number to consider is the discounted net (discounted benefit minus discounted cost). If one alternative clearly has the highest discounted net, it could be considered the best alternative; however, it is usually advisable to look at other factors. See example 5 FAH-5 Exhibit H-621.10-2(2), which illustrates the complexity of using just the discounted net as the basis for determining the best alternative.

c. Alternative 1 has the lowest discounted cost, but it also has the lowest discounted benefit. Alternative 2 has a low discounted cost (but not the lowest) but its discounted benefits are relatively low. Alternative 3 is clearly unacceptable because the discounted net is negative. Alternatives 4 and 5 are both highly desirable because they have the highest discounted nets, but they are also the most costly. Alternative 5 has the highest discounted net, but there may not be $2,500,000 in the budget. In addition, compared to alternative 4, you have $250,000 more to get $300,000 worth of additional benefits.

5 FAH-5 H-621.10-2 Benefit to Cost Ratio

(TL:ITS-1; 02-13-2002)

a. When the alternative with the highest discounted net is not a clear winner, the **benefit to cost ratio** (discounted benefit divided by discounted cost) may be used to differentiate between alternatives with similar or equal discounted nets (see 5 FAH-5 Exhibit H-621.10-2 (1), *Best Benefit to Cost Ratio*). Alternative 4 would be the winner because it has a higher benefit to cost ratio than alternative 5. Alternatives 4 and 5 are clearly superior to the other alternatives because they have the highest discounted net.

b. Another technique is to use the **incremental benefit to cost ratio.** The following exhibits show how this technique would identify the best alternative. 5 FAH-5 Exhibit H-621.10-2 (2), Equal Benefit to Cost Ratios, illustrates an analysis where the two best alternatives have the same discounted net and almost identical benefit to cost ratios, but one alternative has to be selected.

c. See 5 FAH-5 H-621.10-2 (3), Incremental Benefit-Cost-Ratio, for how to compare the increased costs with the associated increased benefits (relative to the lowest cost alternative) can identify the best alternative of two or more with the same benefit-cost ratio.

d. The first step is to arrange the alternatives by discounted cost, lowest to highest.

e. The next step is to calculate the changes in discounted costs and benefit scores. The increases in discounted costs and benefits are computed by subtracting the discounted costs and benefits of alternative 1 from the discounted costs and benefits of alternatives 2, 3, 4, and 5 (n).

f. For alternative 4, spending an additional $750,000 to increase the benefits by $1,205,000 gives a gain in the discounted net of $450,000. This gives an incremental benefit to cost ratio of 1.60. By comparison, alternative 5 gives an incremental benefit to cost ratio of only 1.45, making alternative 4 the best alternative.

g. Alternative 2 has an incremental benefit to cost ratio of 1.5, which is higher than the 1.45 of alternative 5; however; alternative 5 would still be a better alternative because its discounted net and incremental discounted net are greater than the same values for alternative 2.

h. Budget considerations may override the discounted net and the benefit to cost ratio when determining the best alternative. In the previous example, the cost-benefit analysis could be used to increase the budget for a project to $2,255,000; however, if the budget falls between $1,500,000 and $2,025,000, the best alternative would be 2, with a cost of $1,600,000, a discounted net of $150,000, and a cost–benefit ratio of 1.09. An effective cost-benefit analysis may be used to demonstrate that there is a good justification for increasing the $1,600,000 to $2,250,000.

5 FAH-5 H-621.10-3 Evaluate with Intangible Benefits

(TL:ITS-1; 02-13-2002)

a. When all of the benefits are intangible, assign relative numerical values. After the costs have been discounted and the benefits have been quantified, the costs and benefits can be compared and ranked.

b. The simplest way to evaluate alternatives is to directly compare the costs and benefits. For instance, look at 5 FAH-5 Exhibit 621.10-3 (1), Relative Benefit Comparison, alternatives 1 and 5 have the highest relative benefit scores. Alternative 1 would be the clear winner for scenario 1 because it has the lowest cost and the highest benefit. Scenario 2 shows a more common situation where the benefits increase with the higher costs, and there is no clear winner without further analysis.

c. One way to evaluate the alternatives shown in Scenario 2, is to compare the increases in costs and benefits relative to the lowest cost alternative. The first step is to arrange the alternative systems by discounted cost, lowest to highest.

d. The second step is to calculate the changes in discounted costs and benefit scores. The cost change is computed by subtracting the lowest valued cost alternative from the higher valued cost alternative (See 5 FAH-5 Exhibit H-621.10-3 (2), Percentage Increase Ratio). The benefit change is computed in the same manner.

e. The third step is to compute the percentage of change for the costs and benefits of the different alternatives. The percentage cost change for each alternative is computed by dividing the cost change by the lowest valued cost alternative (number 1) and multiplying number by 100 to convert it to a percentage. The percentage benefit change is calculated in the same manner using benefit change instead of cost change.

f. The final step is to compute the percentage increase ratio for each alternative by dividing the, percentage benefit change by the percentage cost change. The best alternative is the one with the highest percentage increase ratio. In this example, the ratio of the percentage benefit change to the percentage cost change is highest for alternative 3. The ratio for alternative 4 is only .13 less than the ratio for alternative 3, indicating there is little difference between the two alternatives. This may be a situation where other factors, such as the amount of funds available, technical risk, or scheduling differences, might be used to finally determine the best alternative.

g. A relatively simple comparison technique is to convert the cost estimates to relative values are comparable to the relative values for the benefits. The first step is to establish a range of relative values from one to ten or one to 100 to allow the differences in the alternative scores to be relatively significant. The dollar cost values will always have to be converted to the new relative values, but the original benefit values will have to be converted to the new relative values, but the original values will have to be converted to the new scale only if their range of values is different from the new range of values. See 5 FAH-5 Exhibit H-621.10-3 (3), Conversion Table, to see the discounted cost being divided by 100,000 and the Benefit Ratings being multiplied by 10 to get comparable values.

h. The 100,000 and 10 are arbitrary numbers and using 10,000 and 1 would produce basically the same results.

i. After the conversion has been completed, the evaluation can be done as shown in 5 FAH-5 Exhibit H-621.10-3 (4), Relative Value Comparison. In this example, the best alternative would be alternative 4, which has the highest benefit-cost ratio by a small margin over alternative 3.

j. The two techniques just discussed both show alternatives 3 and 4 to be clearly the two best alternatives. The fact that different alternatives could be selected using the two different techniques is an indication that the numbers are so close for the two alternatives that there is not a clear difference between them from a cost and benefit perspective. This is clearly a situation where either alternative could be selected, and justified, or other factors could be used as tie breakers.

5 FAH-5 H-621.10-4 Evaluate with Combination

(TL:ITS-1; 02-13-2002)

a. In many cases, proposed systems will have both tangible and intangible benefits, and you will have dollar values and relative values for the benefits. The approach to the evaluation will depend upon whether or not the intangible benefits are significant factors in the cost analysis. The word significant is subjective, and each BCA team will have to decide what that means. If there is no realistic way to relate the value of the intangible benefits to the tangible ones, then they cannot be considered significant for the cost analysis.

b. If the intangible benefits are not considered significant cost factors, they can be used as tie breakers if the evaluation of alternatives does not show that one alternative is a clear winner on the basis of net present value, benefit to cost ratio, or the incremental benefit to cost ratio. That process was described in step 1, therefore, a sample case is not included.

c. When intangible benefits are significant factors in the analysis, there are two options that may be exercised. If it is possible, the relative values may be converted to dollar values. This is a difficult thing to do, and may be impossible to defend. There is no proven basis for assigning a dollar value to a benefit such as lower technical risk, and the amount of the dollar value could be used to influence the selection of the best alternative. Ultimately, the issue is whether or not it can be justified to the individual(s) that reviews and approves the BCA. The advantage is that you are working with all dollar values, and the evaluation process is simpler than the second option, which is converting dollar values to relative values.

d. The second option when the intangible benefits are significant factors in the analysis is to convert the dollar value of the tangible benefits to the same rating scale as the relative values of the intangible benefits. See 5 FAH-5 Exhibit H-621.10-4 (1), Mixed Benefit Values. This shows a case where five of the seven benefits have been assigned dollar values, and two were assigned relative numeric values.

e. In this example, the dollar values can be converted to numerical scale values between 0 and 5 by dividing by $100,000. See 5 FAH-5 Exhibit H-621.10-4 (2), Converted Benefit Values. This shows the rating after they have all been converted to scaled values.

f. At this point, the analysis can proceed by using the evaluation techniques for the situation where the benefits are not assigned dollar values.

g. Sometimes the relative values of benefits are not all equal. When that is the case, the scaled values can be assigned different weights; apply the weighting factors to the scaled values. See 5 FAH-5 Exhibit H-621.10-4 (3), Weighted Relative Benefits, for the weighting of the scaled values for the benefits for two alternatives. It demonstrates that when the weighting is applied the scores for alternative 1 are lower than alternative 2; while the raw scores of alternative 1 are lower than alternative 2.

5 FAH-5 H-621.10-5 Flexibility

(TL:ITS-1; 02-13-2002)

The different methods for evaluating alternatives provides a great deal of flexibility in selecting the best alternative; however, the evaluation technique must withstand the scrutiny of an investment review group that will ask hard questions about the entire analysis process. You may want to use two techniques to see if the same alternative is selected. If two different techniques select the same alternative, it should indicate that the analyses are valid and accurate. Another way to validate a benefit-cost analysis is through a sensitivity analysis, which is addressed in detail in the next section.

5 FAH-5 H-621.11 Step 11—Perform Sensitivity Analysis

(TL:ITS-1; 02-13-2002)

Sensitivity analysis tests the sensitivity of input parameters and the reliability of the results obtained from the benefit-cost analysis. Since the benefit-cost analysis is the essential document in the investment review process, reviewers will want assurance that the analysis is valid. They are likely to ask questions about the accuracy of different parameters and cost estimates and their impact on the final recommendation. The sensitivity analysis should assure reviewers that the analysis provides a sound basis for making decisions regarding the proposed project. The sensitivity analysis process requires three steps:

(1) Identification of input parameters with the greatest influence on the outcome;

(2) Repetition of the cost analysis; and

(3) Evaluation of the results.

5 FAH-5 H-621.11-1 Identify Input Parameters

(TL:ITS-1; 02-13-2002)

The ground rules and assumptions documented earlier in the benefit-cost analysis are now used to identify the model inputs to be tested for sensitivity. hput parameters that are good candidates for testing are those that are both significant (large) cost factors and have a wide range of maximum and minimum estimated values. Some common parameters to be considered include the following:

(1) System requirement definition costs;

(2) System development costs;

(3) System operation costs;

(4) Transition costs, especially software conversion;

(5) System life cycle;

(6) Peak system demands; and

(7) Dollar values and relative values for benefits.

5 FAH-5 H-621.11-2 Repeat the Cost Analysis

(TL:ITS-1; 02-13-2002)

a. The repetition of the cost analysis includes the following steps:

(1) Choose one of the parameters selected for testing;

(2) Determine the minimum and maximum values for that parameter;

(3) Choose the minimum or maximum value as the new parameter value (the number selected should be the one that differs the most from the value used in the original analysis);

(4) Repeat the benefit-cost analysis with the new parameter value;

(5) Document the results; and

(6) Repeat steps 1 through 5 above until all-important parameters have been tested.

b. After repeating the above process for several different parameters, you will have a set of outcomes that correspond to a given set of inputs. Some analysts may want to do a "worst case" scenario where several parameters are set to their worst possible values. Tabulation of the results will provide a summary of the different outcomes, allowing the results to be quickly evaluated, as shown below.

c. Compare the original set of inputs and the resulting evaluation outcome to the outcomes obtained by varying the input parameters. In example 5 FAH-5 Exhibit H-621.11-2, Sensitivity Analysis Summary, the original values are the first listed for each parameter. Sensitivity is measured by how much change in a parameter is required to change the alternative selected in the original analysis. Sensitivity is another subjective word, so the following guidelines are provided:

(1) A parameter is not considered sensitive if it requires a decrease of 50% or an increase of 100% to cause a change in the selected alternative.

(2) A parameter is considered to be sensitive if a change between 10% and 50% causes a change in the selected alternative.

(3) A parameter is considered to be sensitive if a change of 10% or less causes a change in the selected alternative.

d. In 5 FAH-5 Exhibit H-621.2-4, the analysis would appear to be sensitive to the development costs, but not sensitive to the transition costs and benefits. The selection of three different alternatives based on three different system life cycles demonstrates that system life cycle is an important parameter, and illustrates that the guidelines above cannot be use as absolute criteria.

e. Sensitive parameters warrant further study. Assumptions, data sources, and analyses should be revisited to ensure that the best possible value is used for that parameter. If the analysis is found sensitive to several parameters, return to the beginning of the analysis and review all ground rules and assumptions. The final benefit-cost analysis report should include a sensitivity analysis that demonstrates sensitive parameters have been carefully investigated and the best possible values have been used in the final analysis.

5 FAH-5 H-622 BENEFIT COST ANALYSIS SUMMARY

5 FAH-5 H-622.1 BCA Review Checklist

(TL:ITS-1; 02-13-2002)

A BCA review checklist is found in 5 FAH-5 Exhibit H-622.1.

5 FAH-5 H-622.2 BCA Outline

(TL:ITS-1; 02-13-2002)

A sample simplified BCA outline is in 5 FAH-5 Exhibit H-622.2(1) and a sample BCA outline is in 5 FAH-5 Exhibit H-622.2(2).

5 FAH-5 H-623 THROUGH H-629 UNASSIGNED

5 FAH-5 H-621 Exhibit H-621.2-4
COST ELEMENT TABLE

(TL:ITS-1; 02-13-2002)

Cost Category	Cost Elements
Equipment, Leased or Purchased	Super-computers; mainframes; mini-computers; microcomputers; disk tape drives; printers; telecommunications; voice and data networks; modems; data encryption devices; and facsimile equipment.
Software, Leased or Purchased	Operating systems; utility programs; diagnostic programs; application and commercial-off-the-shelf (COTS) software (word processing, communications, graphics, database management, and server software).
Commercial Services	Commercially provided services, such as teleprocessing, local batch processing, on-line processing, Internet access, and electronic mail.
Support Services (Contractor Personnel)	Commercially provided services to support equipment, software, or servers such as maintenance, source data entry, training, planning.
Supplies	Any consumable item designed specifically for use with equipment, support services identified above.
Personnel (Compensation and Benefits)	Includes the salary (compensation) and benefits for government personnel (civilian and or military) who perform information technology functions more of their time.
Intra-governmental Services	All information technology services within agencies, between Executive agencies.

5 FAH-5 H-621 Exhibit H-621.3-1
SYSTEM LIFE CYCLE MANAGEMENT

(TL:ITS-1; 02-13-2002)

MSP PERIODS	TRADITIONAL SYSTEM LIFE CYCLE PHASE	TASKS
Study	Initiation	-To select among alternative development approaches for satisfying user requirements. -To describe and quantify the costs and benefits of all feasible alternatives and applicable resources required satisfying a given objective. -To defend the chosen alternative as the most cost effective and beneficial approach to develop the system. -To provide consistency in the selection, calculation, and presentation of cost and benefit data. -To effect a more precise comparison of alternative system development approaches.
	Concept Definition Phase	-To select which program initiatives to include within existing budget constraints. -Go and/or No-Go decisions at the budget request levels. -To comply with OMB Circ A-11 for IT Program initiatives that exceed $30M during the system life cycle of if the cost in any one-year exceeds $10M.
	Acquisition Planning	-To validate costs and benefits to obtain acquisition approval. -To comply with FIRMR Chapter 201 for competitive acquisitions exceeding $2.5M during the system life cycle or non-competitive acquisitions exceeding $250,000. -To support an agency's submission of an agency procurement request to GSA requesting a Delegation of Procurement Authority. -To assist in determining the most advantageous acquisition approach (lease, buy, and contractor, in-house).
Acquisi-tion		-To assist in Go and/or No Go decisions at the end of each life cycle phase. -To select the appropriate course of action before any new commitment of resources. -To ensure management accountability for costs and benefits as the project continues. -To serve as visible evidence that all economic factors bearing on the recommended alternatives have been considered. -To defend and validate the recommended alternative as the project continues. -To reflect changing project requirements or changes in the initial assumptions and constraints.

Opera- tions & Mainte- nance	Operation	-To compare actual performance with the estimated costs and benefits. -To assist in detecting obsolescent projects and those with low payoffs relative to costs so that decisions can be made relative to their continuation. -To serve as historical baselines that can assist in estimates which are made for future BCAs.

5 FAH-5 H-621 Exhibit H-621.3-2
AVERAGE ANNUAL INCREASE

(TL:ITS-1; 02-13-2002)

Demand	1993	1994	1995	1996	1997
# of Users	1150	1275	1350	1550	1681
% Change		10.87%	5.88%	14.81%	8.45%
Average %					10.00%

5 FAH-5 H-621 Exhibit H-621.7-1
SYSTEM LIFE-CYCLE COST MATRIX

(TL:ITS-1; 02-13-2002)

ACTIVITY	TASK	COST ELEMENTS
Project Initiation	Problem Definition	Analysts, Managers, Processors, Customers
	Work Process Evaluation	Analysts, Managers, Processors, Customers
	Processing Requirements Definition	Analysts, Managers, Processors, Customers
	Security Planning	Analysts, Managers, Processors, Customers
	Develop IT Performance Measures	Analysts, Managers, Processors, Customers
	Prepare Cost Benefit Analysis	Analysts, Managers, Processors, Customers
IT Resources Acquisition	Develop Statement of Work	Analysts, Managers, Processors, Customers
	Award Contract	Project Manager, Contractor personnel
	Monitor Contract	Project Manager, Contractor personnel, Finance Personnel
System Design	Develop System Design	Analysts, Managers, Processors
	Approve System Design	Analysts, Managers, Processors
System Development	Develop and Test Programs and Procedures	Analysts, Managers, Processors, Programmers, Computers, Software
	Develop Transition Plan	Analysts, Managers, Processors, Programmers, Computers, Software
	Implement New System and Procedures	Analysts, Managers, Processors, Programmers, Computers, Software
System Operations	Operate New System	Analysts, Managers, Processors

		Programmers, Computers, Software
System Maintenance	Correct Errors and Make Changes to the System	Analysts, Managers, Processors, Programmers, Computers, Software
System Evaluation	Evaluate System Performance Compared to Expectations	Analysts, Managers, Processors, Customers
System Management	Oversee System	Project Manager, Managers

5 FAH-5 H-621 Exhibit H-621.7-4
TANGIBLE ASSET DEPRECIATION

(TL:ITS-1; 02-13-2002)

Year	0	1	2	3	4
Annual Depreciation		$1,800	$1,800	$1,800	$1,800
Book Value	$10,000	$8,200	$6,400	$4,600	$2,800

5 FAH-5 H-621 Exhibit H-621.8-6 (1)
QUANTIFY INTANGIBLE BENEFITS

(TL:ITS-1; 02-13-2002)

Benefit	Reviewer 1 Score	Reviewer 2 Score	Reviewer 3 Score	Reviewer 4 Score	Reviewer Average Score
A	5	4	3	5	4.25
B	4	2	3	4	3.25
C	3	2	5	4	3.50
D	4	3	2	2	2.75
E	2	3	1	4	2.50

5 FAH-5 H-621 Exhibit H-621.8-6 (2)
WEIGHTED SCORING

(TL:ITS-1; 02-13-2002)

Benefit	Alternative 1 Raw Score	Alternative 2 Raw Score	Weighting Factor	Alternative 1 Weighted Score	Alternative 2 Weighted Score
A	4	2	10	40	20
B	3	3	9	27	27
C	3	2	9	27	18
D	4	3	8	32	24
E	2	3	6	12	18
F	3	4	5	15	20
G	2	4	5	10	20
TOTAL	21	21		163	147

5 FAH-5 621 Exhibit H-621.9
DISCOUNTED COSTS AND BENEFITS

(TL:ITS-1; 02-13-2002)

Year	Annual Costs	Annual Benefit	Discount Factor	Discounted Cost (DC)	Discounted Benefit (DB)	Discounted Net
	AC	AB	DF	ACxDF	ABxDF	DB-DC
1	150,000		0.9667	145,010	-	(145,010)
2	600,000		0.9035	542,095	-	(542,095)
3	280,000	400,000	0.8444	236,428	337,754	101,326
4	260,000	400,000	0.7891	205,178	315,658	110,480
5	300,000	400,000	0.7375	221,256	295,007	73,752
6	300,000	400,000	0.6893	206,781	275,708	68,927
7	240,000	400,000	0.6442	154,603	257,671	103,068
8	230,000	400,000	0.6020	138,468	240,814	102,346
9	230,000	400,000	0.5626	129,409	225,060	95,650
10	230,000	400,000	0.5258	120,943	210,336	89,393
Total	2,820,000	3,200,000		2,100,171	2,158,008	57,837

5 FAH-5 H-621 Exhibit H-621.10-1 (1)
A CLEAR WINNER

(TL:ITS-1; 02-13-2002)

Alternative	Discounted Cost (DC)	Discounted Benefit (DB)	Discounted Net (DB-DC)	Benefit to Cost Ratio (DB and/or DC)
1	1,800.000	2,200,000	400,000	1.22
2	1,850,000	1,750,000	(100,000)	0.95
3	2,000,000	2,000,000	-	1.00
4	2,200,000	2,100,000	(100,000)	0.95

5 FAH-5 H-621Exhibit H-621.10-1 (2)
NO CLEAR WINNER

(TL:ITS-1; 02-13-2002)

Alternative	Discounted Cost (DC)	Discounted Benefit (DB)	Discounted Net (DB-DC)	Benefit to Cost Ratio (DB and/or DC)
1	1,500,000	1,600,000	100,000	1.07
2	1,600,000	1,750,000	150,000	1.09
3	2,000,000	1,800,000	(200,000)	0.90
4	2,250,000	2,500,000	250,000	1.11
5	2,500,000	2,800,000	300,000	1.12

5 FAH-5 H-621 Exhibit H-621.10-2 (1)
BEST BENEFIT TO COST RATIO

(TL:ITS-1; 02-13-2002)

Alternative	Discounted Cost (DC)	Discounted Benefit (DB)	Discounted Net (DB-DC)	Benefit to Cost Ratio (DB and/or DC)
1	1,500,000	1,600,000	100,000	1.07
2	1,600,000	1,750,000	150,000	1.09
3	1,900,000	2,000,000	100,000	1.05
4	2,000,000	2,450,000	450,000	1.23
5	3,000,000	3,450,000	450,000	1.15

5 FAH-5 H-621 Exhibit H-621.10-2 (2)
EQUAL BENEFIT TO COST RATIOS

(TL:ITS-1; 02-13-2002)

Alternative	Discounted Cost (DC)	Discounted Benefit (DB)	Discounted Net (DB-DC)	Benefit to Cost Ratio (DB and/or DC)
1	1,500,000	1,600,000	100,000	1.07
2	1,600,000	1,750,000	150,000	1.09
3	2,000,000	1,800,000	(200,000)	0.90
4	2,255,000	2,805,000	550,000	1.24
5	2,500,000	3,050,000	550,000	1.22

5 FAH-5 H-621 Exhibit H-621.10-2 (3)
INCREMENTAL BENEFIT-COST-RATIO

(TL:ITS-1; 02-13-2002)

Alternative (n)	Increase in Discounted Cost (IDC) (DC, Alt. n-DB, Alt. 1)	Increase in Discounted Benefit (IDB) (DB, Alt, n-DB, Alt. 1)	Incremental Discounted Net (IDB-IDC)	Incremental Benefit to Cost Ratio (IDB and/or IDC)
1	100,000	150,000	50,000	1.50
2	500,000	200,000	(300,000)	0.40
3	755,000	1,205,000	450,000	1.60
4	1,000,000	1,450,000	450,000	1.45

5 FAH-5 H-621 Exhibit H-621.10-3 (1)
RELATIVE BENEFIT COMPARISON

(TL:ITS-1; 02-13-2002)

Alternative	Converted Cost (CC)	Converted Benefit (CB)	Benefit to Cost Ratio CB and/or CC
1	15.00	22.00	1.47
2	16.00	23.00	1.44
3	20.00	35.00	1.75
4	22.50	40.00	1.78
5	25.00	42.50	1.70

5 FAH-5 H-621 Exhibit H-621.10-3 (2)
PERCENTAGE INCREASE RATIO

(TL:ITS-1; 02-13-2002)

Alternative (n)	Discounted Cost (DC)	Benefit Rating (BR)	Benefit Change (BC) BR(n) BR(1)	Cost Change (CC) DC(n)-DC (1)	% Benefit Change (%CC) BC and/or BR (1)	% Cost Change (%CC) CC and/or DC (1)	%Increase Ratio %BC/% CC
1	1,500,000	2.20					
2	1,600,000	2.30	0.10	100,000	5%	7%	0.68
3	2,000,000	3.50	1.30	500,000	59%	33%	1.77
4	2,250,000	4.00	1.80	750,000	82%	50%	1.64
5	2,500,000	4.25	2.05	1,000,000	93%	67%	1.40

5 FAH-5 H-621 Exhibit H-621.10-3 (3)
CONVERSION TABLE

(TL:ITS-1; 02-13-2002)

Alternative	Discounted Cost (DC)	Conversion Factor (CF) 1/100,000	Converted Cost (CC) DCxCF	Benefit Rating (BR)	Conversion Factor (CF) 10	Converted Benefit BRxCF
1	1,500,000	0.00001	15.00	2.20	10	22.00
2	1,600,000	0.00001	16.00	2.30	10	23.00
3	2,000,000	0.00001	20.00	3.50	10	35.00
4	2,250,000	0.00001	22.50	4.00	10	40.00
5	2,500,000	0.00001	25.00	4.25	10	42.50

5 FAH-5 H-621 Exhibit H-621.10-3 (4)
RELATIVE VALUE COMPARISON

(TL:ITS-1; 02-13-2002)

Alternative	Discounted Cost	Benefit Score Scenario 1	Benefit Score Scenario 2
1	1,500,000	2.20	2.20
2	1,600,000	2.10	2.30
3	2,000,000	2.00	3.50
4	2,250,000	2.10	4.00
5	2,500,000	2.20	4.25

5 FAH-5 H-621 Exhibit H-621.10-4 (1)
MIXED BENEFIT VALUES

(TL:ITS-1; 02-13-2002)

Benefit	Reviewer 1 Score	Reviewer 2 Score	Reviewer 3 Score	Reviewer 4 Score	Reviewer Average Score
A	100,000.00	75,000.00	90,000.00	105,000.00	92,500.00
B	4.50	2.00	3.25	4.00	3.44
C	200,000.00	225,000.00	150,000.00	175,000.00	187,500.00
D	4.00	3.75	2.50	2.00	3.06
E	500,000.00	400,000.00	450,000.00	375,000.00	431,250.00
F	300,000.00	275,000.00	325,000.00	300,000.00	300,000.00
G	200,000.00	400,000.00	500,000.00	30,000.00	282,500.00

5 FAH-5 H-621 Exhibit H-621.10-4 (2)
CONVERTED BENEFIT VALUES

(TL:ITS-1; 02-13-2002)

Benefit	Reviewer 1 Score	Reviewer 2 Score	Reviewer 3 Score	Reviewer 4 Score	Reviewer Average Score
A	1.00	0.75	0.90	1.05	0.93
B	4.50	2.00	3.25	4.00	3.44
C	2.00	2.25	1.50	1.75	1.88
D	4.00	3.75	2.50	2.00	3.06
E	5.00	4.00	4.50	3.75	4.31
F	3.00	2.75	3.25	3.00	3.00
G	2.00	4.00	5.00	3.00	3.50

5 FAH-5 H-621 Exhibit H-621.10-4 (3)
WEIGHTED RELATIVE BENEFITS

(TL:ITS-1; 02-13-2002)

Benefit	Alternative 1 Raw Score	Alternative 2 Raw Score	Weighting Factor	Alternative 1 Weighted Score	Alternative 2 Weighted Score
A	0.92	0.50	12.00	11.10	6.00
B	3.44	2.75	10.00	4.38	27.50
C	1.88	2.25	9.00	6.88	20.25
D	3.06	3.80	5.00	15.31	19.00
E	4.31	3.10	3.00	12.94	9.30
F	3.00	4.60	2.00	6.00	9.20
G	3.50	4.70	1.00	3.50	4.70
TOTAL	20.11	21.70		100.10	95.95

5 FAH-5 H-621 Exhibit H-621.11-2
SENSITIVITY ANALYSIS SUMMARY

(TL:ITS-1; 02-13-2002)

Parameter	Parameter Value	Best Alternative
Development Cost ($)	1,500,000 2,000,000 2,500,000	A A B
Transition Cost ($)	100,000 200,000	A A
System Life Cycle (Years)	5 10 15	A B C
Benefits ($)	1,500,000 2,250,000 3,000,000	A A A

5 FAH-5 H-622 Exhibit H-622.1
BCA REVIEW CHECKLIST

(TL:ITS-1; 02-13-2002)

OBJECTIVE

1. Is the objective clearly stated? Does it define the purpose of the program and/or project or activity?

2. Is the objective realistic and attainable?

3. Is the objective stated in terms of output or accomplishment?

4. Are the output and/or accomplishments defined in quantifiable, measurable terms?

5. Can progress toward attainment of the objective be measured?

6. If a completion or implementation date is required, has it been specified?

ASSUMPTIONS and/or CONSTRAINTS

1. Are all reasonable assumptions identified and explained?

2. Are assumptions too restrictive? Too broad?

3. Are assumptions realistic and justified?

4. Are assumptions used only when facts cannot be obtained?

5. Do assumptions include economic life and future work loads?

6. Is a project time frame established?

7. Are funding and/or budget constraints considered?

8. Are space and construction needs included?

9. Are necessary geographical constraints included?

ALTERNATIVES

1. Have all feasible alternatives been considered?

2. Are the alternatives feasible? Can they meet the stated objectives?

3. Are the alternatives well defined and discreet? Do they overlap?

4. Is the status quo used as a base for comparison?

5. If appropriate, is leave vs. buy evaluated?

6. Have non-analyzed alternatives been identified with reasons for omission?

7. Have other U.S. Government agencies been included as alternatives?

BENEFITS

1. Have all relevant benefits been determined?

2. Are the benefits identified in quantifiable, measurable terms as much as possible?

3. Are estimating techniques defined?

4. Are information and/or estimation sources identified?

5. Was an expert opinion used? Were the experts properly qualified?

6. When measuring quantitative for mission, are there logical, convincing assessments?

7. Have cost reductions (i.e., savings) been excluded from the benefit list to avoid double counting?

8. Has a ranking or priority system been developed for evaluating the importance of the benefits?

9. Has all benefit information been tabulated for ease of examination?

COST ESTIMATE

1. Are all relevant costs included?

2. Are cost factors current and supportable?

3. Do implementation costs include shipping, installation, support and training requirements?

4. Do labor costs consider specific skill levels, fringe benefits, overtime and shift differentials?

5. Is future equipment replacement included as an investment cost?

6. Are sunk costs excluded?

7. Have opportunity costs been considered?

8. Are future costs evaluated in terms of constant dollars? If inflation or cost escalation is included, have the rate and rate source been identified? Are costs saving or avoidance determined only by comparing with the status quo?

COMPARING ALTERNATIVES

1. Were the proper techniques used (i.e., present value, benefit and/or cost rates, break-even analysis)?

2. Does the analysis seem free of bias in favor of a particular alternative?

3. Were the criteria, costing methods, and time span the same for all alternatives?

4. Have benefits and costs for each alternative been combined to show relationships?

5. Were the methods and sources adequately documented?

SENSITIVITY ANALYSIS

1. Are there important underlying uncertainties in the analysis?

2. Is there important technological uncertainty?

3. Were ranges of values used for unknown quantities?

4. Has the impact of the length of time for formal project approval been illustrated?

5. Is the analysis too optimistic in its assumptions?

6. Is there a sensitivity analysis to show the effect of uncertainty in major cost estimates?

CONCLUSIONS

1. Are the results of the analysis conclusive? Can concrete ranking of alternatives be established?

2. Has a specified course of action been recommended?

3. Are the conclusions logically derived from the material?

4. Have all significant differences between the recommended alternative and others been emphasized?

5. Are the recommendations feasible in the real world of political, cultural, or policy considerations?

5 FAH-5 H-622 Exhibit H-622.2 (1)
SIMPLIFIED BENEFIT COST ANALYSIS (BCA) OUTLINE (SAMPLE)

(TL:ITS-1; 02-13-2002)

EXECUTIVE SUMMARY: Summarize findings and conclusions. Briefly, describe objective, alternative analysis and ranking, and recommendations and conclusions.

TABLE OF CONTENTS. (Must follow the outline).

I. INTRODUCTION

A. Background. Briefly describe existing environment. Describe the specific problem or deficiency along with an historical account of major events leading to the problem. The analyst **may** provide a summary of the procedures used to conduct the BCA and the techniques used to estimate benefits and costs. Include detailed techniques in the appendix, not in the main body of the report.

B. Objective. State the scope and purpose of the BCA (i.e., if the analysis focuses on exploring four alternatives to satisfying the objectives of the project, state such).

C. Requirements. State the major requirements of the project. State requirements in terms of the functional need (performance and operational characteristics) without implying how they are to be accomplished.

D. Assumptions. State all applicable assumptions. Include the economic life of the alternatives along with the time period of comparison. Also include any constraints, limitations, or exclusions related to conducting the analysis not to exceed 3.

E. Alternatives. Describe the technical and operational characteristics of each Feasible alternative, including the existing system. If an alternative is considered but is shown infeasible, there is no need to quantify associated benefits and costs for purposes of comparison. However, address the infeasible alternatives in this section not to exceed 3.

II. ANALYSIS OVERVIEW. One of the basic concepts of Benefit Cost Analysis is not to consider sunk costs (money already spent). This is consistent with the IRMPBs purpose, which is to determine whether or not to proceed with the project according to plan. This analysis will also show the historical costs for design, development and implementation so they can be compared to the estimates in the benefit-cost analysis prepared for the detailed review. This should also show the breakdown cost during the project life cycle.

III. COSTS. Identify and describe the cost elements for each alternative. Include the computations used to derive the total costs and describe the techniques used to develop the detailed cost estimates. Use tables, charts, graphs, mathematical models, etc., to assist in presenting the costs.

IV. BENEFITS. Identify and describe all benefits expected by implementing each alternative. Quantify benefits whenever possible. Identify the criteria used to measure benefits and include any computations when applicable. Also provide a general narrative of all intangible benefits.

V. COMPARISON OF COSTS AND BENEFITS. Compare alternatives using one of the BCA comparison techniques. Present the results in an easily understood format. Whenever the comparison period is greater than three years, the alternatives must be compared in term of discounted costs and benefits (i.e., breakdown analysis between common products).

VI. CONCLUSIONS. Briefly present conclusions for the most important findings. Do not introduce any new material at this point in the report. Discussions in the main body of the report should be substantiated in this section.

VII. RECOMMENDATIONS. The obvious decision rule for making an economic choice between several alternatives is to choose the highest net present value. Break even analysis techniques.

5 FAH-5 H-622 Exhibit H-622.2 (2)
BENEFIT COST ANALYSIS (BCA) (SAMPLE)

(TL:ITS-1; 02-13-2002)

BENEFIT AND/OR COST ANALYSIS

MODERIZATION OF PAYROLL SYSTEM

PREPARED BY

JOHN E. DOE

DS/IMPD/PL/SSD

Department of State

January 10, 2000

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Department's payroll needs have outgrown the current computer-processing environment. The current System XYZ requires modification to implement changes to comply with new requirements of the Office of Management and Budget and the Office of Personnel. The Department also has several planned system modifications designed to increase efficiency and timeliness. Not all sites are capable of supporting the new requirements because of inadequate central processing unit, memory capacity, and input and/or output connections. This analysis focuses on selecting an equipment configuration capable of implementing all stated requirements. The objective is to examine the benefits and costs of alternatives that will satisfy both current and proposed requirements of the Department's payroll system.

The three alternatives considered are:

1. **Baseline (status quo)**. Keep current System XYZ. Make system modifications to maintain performance at current levels. Meet new requirements by increasing manual processing of system information. No planned enhancements will be implemented.

2. **Shared upgrade**. Replace existing computer equipment with eight new minicomputers. Each new computer will support operations at two locations. (Headquarters will not share with any other location.) Half of the locations would be linked to a computer at another location via telecommunications. All planned enhancements and additional requirements will be phased in over the life cycle of the equipment.

3. **Conversion to centralized hardware**. Replace the current System XYZ with a mainframe system. Each location will be linked to the host computer via leased lines. Current software will be converted to run on the mainframe. Current operations, planned enhancements, and new equipment will be implemented by year 4 of the comparison period.

Both a benefit analysis and a cost analysis were conducted. The results concluded that it is more cost-effective and beneficial to implement the shared upgrade alternative (#2). Under all scenarios, the shared upgrade alternative is clearly superior and reinforces the results of the original BCA analysis. In this study, both the net present value (NPV) analysis and benefit and/or cost ratio (BCR) rank the shared upgrade alternative as the best choice. The following chart shows the NPV and BCR for each alternative. The chart on page 5 shows that the conversion alternative and the present system are not economically desirable. Both the shared and total upgrade alternatives appear to be desirable; both have positive NPVs and BCRs greater than 1. The BCR of the shared upgrade alternative is clearly superior to all other alternatives. The total upgrade alternative was evaluated as marginally better than the shared upgrade alternative on non-quantifiable benefits. This difference is outweighed by the higher NPV

(37% higher) of the shared upgrade. Therefore, based on the analysis of benefit and costs, the shared upgrade alternative is clearly the recommended alternative.

SYSTEM XYZ UPGRADE
COMPARISON OF ALTERNATIVES

ALTERNATIVE	PRESENT VALUE COSTS	PRESENT VALUE BENEFITS	NET PRESENT VALUE	BENEFIT/ COST RATIO
CURRENT	4,249,910	2,283,000	(1,966,910)	.54
SHARED	3,946,360	5,004,038	1,057,678	1.27
CONVERSION	6,544,120	3,804,304	(2,739,780)	.54

I. INTRODUCTION

A. **Background**. In 1980, the Department developed System XYZ to process payroll, time and attendance, and related personnel information. System XYZ runs on minicomputers at 15 sites around the country. The current system requires modification to comply with requirements changed by the Office of Management and Budget (OMB), and the Office of Personnel Management (OPM). Also, the Department has several planned system modifications designed to increase efficiency and timeliness. Not all sites are capable of supporting the new requirements because of inadequate central processing unit (CPU), memory capacity, and input and/or output connections.

B. **Objectives**. This analysis focuses on selecting an equipment configuration capable of implementing all stated requirements. The objective of the benefit and/or cost analysis is to examine the benefits and costs of three alternative configurations capable of satisfying both the current and proposed requirements of the Department's payroll system.

C. **Requirements.**

(1) The System XYZ reference manual (cite specific source document here, if possible) identifies the following existing requirements:

(a) Maintain a single resource database that includes all necessary employee data;

(b) Provide access to individual and summary data for authorized managers;

(c) Process all personnel and time reporting transactions efficiently; and

(d) Provide statistical reports for submission to Congress, OMB, and OPM.

(2) The system redesign team developed specific requirements for the proposed system modifications.

(a) Enhance system edits, validity checks, and processes to improve the accuracy of payroll system information.

(b) Conform to new and revised Federal regulations, legislation, and external requirements.

(c) Eliminate manual preparation of reports and updates.

(e) Maintain current processing capability with no degradation of service during modification effort.

(f) Support 15 sites and allow for future expansion.

D. **Assumptions.** The following assumptions were made in conducting the analysis. These assumptions formed the basis for analysis, extrapolations and projections.

(1) The life cycle of each alternative is 7 years. At that point, additional computer resources will be required.

(2) The comparison period is the same as the assumed life cycle (7 years) beginning in FYXX (year 0).

(3) Current computer equipment can be exchanged for a credit during an upgrade of the existing vendor's equipment.

(4) All minicomputer upgrades will remain in the existing vendor's line of equipment.

(5) All new equipment will be delivered in September 20XX.

(6) Existing workload and operating costs will remain constant during the comparison period.

(7) Incremental benefits will be analyzed for items where alternative(s) improve upon the current system.

E. **Alternatives**. Three alternatives were considered during the analysis. The following alternatives are capable of meeting all requirements.

(1) **Baseline (status quo).** System XYZ will continue to operate as it does today. System modifications will be made to maintain performance at current levels. New requirements will be met by increasing manual processing of system information. No planned enhancements will be implemented.

(2) **Shared upgrade**. The existing computer equipment will be replaced by eight new minicomputers. Each new computer will support the operations of two locations. (Headquarters will not share with any other location.) Half of the locations would be linked to a computer at another location via telecommunications. All planned enhancements and additional requirements will be phased in over the life cycle of the equipment.

(3) **Conversion to centralized hardware**. The current System XYZ will be replaced with mainframe system. Each location will be linked to the host computer via leased lines. Current software will be converted to run on the mainframe. Current operations, planned enhancements, and new equipment will be implemented by year 4 of the comparison period.

II. ANALYSIS OVERVIEW

The benefits that should result from a redesign of System XYZ can be organized into two categories: quantifiable and non-quantifiable.

Quantifiable benefits represent clear monetary savings through cost reduction and cost avoidance. Non-quantifiable benefits result from greater efficiency of operations and include areas such as improved employee morale and increased management efficiency.

A. **Quantifiable benefits**. Quantifiable benefits were established in four categories:

(1) Cost Avoidance—personnel;

(2) Cost Reduction—equipment maintenance;

(3) Cost Reduction—forms printing and storage; and

(4) Non-Recurring Benefit—trade-in value of equipment.

Benefits were measured individually for each location and then summarized for the entire system. (Detailed estimates by location are not included in this example.)

(a) Cost Avoidance—Personnel

Revisions to System XYZ are needed to meet new requirements. Site visits were made to five locations to investigate how these changes could be implemented. Work flows and the analyst in conjunction developed processing times with supervisors and managers. Estimates of the number of transactions and reports were developed by the System XYZ manager. This provided an estimate of the number of full-time employees (FTEs) required to accomplish the changes. Phone interviews were conducted with managers at the remaining locations to assure that estimates were reasonable. This process resulted in an estimate of the number of FTEs required to implement changes at each site. These estimates represent personnel who will not be required if one of the alternatives to the status quo is selected. For the shared and total upgrade alternative, these benefits were phased in over a 5-year period beginning in year 1. This accounted for the time required developing, testing, and implementing the changes. For the conversion alternative, full enhancement is expected at implementation of the new system in year 4. FTEs were converted to dollars using an average cost of $45,000 per FTE. This represents the average cost of current System XYZ staff including fringe benefits and identifiable overhead.

(b) Cost Reduction—Equipment Maintenance.

The Department currently pays $120,000 for a one-year, four-hour response maintenance agreement on 15 computers. The cost for a similar agreement for the proposed replacement minicomputers is $106,500 for the share upgrade alternative and $115,000 for the total upgrade alternative. The savings were based on price quotes from the current maintenance contractor. The cost for maintenance on the mainframe would be shared

with other resident systems. The estimated allocation of costs to System XYZ was $125,000. This estimate was provided by the manager of the administrative systems office based on recent allocations to similar systems. Therefore, no benefit was added for the conversion alternative.

(c) Cost Reduction—Form Printing and Storage.

The Department currently pays $10,000 per year to print forms required for system input and reporting. In addition, the system is assessed $90,000 per year by warehouse operations for storage and distribution of forms to 15 sites. Proposed system enhancements will eliminate the need for two different forms. These forms represent about 5 percent of all forms used by the system (based on a 1-month sample at 5 locations). This reduction results in a $5,000 savings to the Department for all alternatives. Since both managers and systems operations list these as the top priority for system enhancement, they will be implemented first. Benefits are anticipated to begin in year 1 for the total and shared upgrade alternatives and in year 4 for the conversion alternative.

(d) Non-Recurring Benefit—Trade-in Value of Equipment.

For the shared and total upgrade alternatives, a proposed equipment configuration was developed for each site. Where possible, existing equipment (disk packs, terminals, etc.) was used in these configurations. The analysts then developed a list of surplus equipment. Since the current equipment manufacturer provides a credit to customers who upgrade within the same product line, they were asked for a quote on the list of displaced equipment. These figures were included as a non-recurring benefit in year 0 for the shared and total upgrade alternatives. No trade-in credit would be available under the conversion alternative. Excess equipment is assumed to be used by the Department for other applications.

SUMMARY. The analysts completed a benefit analysis worksheet for each alternative. The benefit worksheet provided the total benefits for the alternative in each year of the comparison period. Chart A shows the benefit analysis worksheet for the shared upgrade alternative. (**Note:** When preparing an actual BCA, the analyst would, of course, include worksheets for all alternatives). Chart B summarizes the total benefits for each alternative and provides the net present value for the benefits. As shown by the net present value figures, the benefits for the shared and total upgrade are very close (less than 1 percent difference). The benefits for the conversion and baseline alternatives are substantially less (more than 20 percent) than the other two alternatives.

CHART A
BENEFIT ANALYSIS

(000s omitted)

Benefit Category	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
Nonre-curring Benefits Upgrade credit	618							618
Subtotal	618							618
Recurring Benefits								
Cost Avoidance Personnel		113	495	878	1,215	1,620		6,256
Cost Reduction		13.5	13.5	13.5	13.5	13.5		81
Maintained Forms		5	5	5	5	5		30
Subtotal		131.5	513.5	896.5	1,233.5	1.638.5		6,387
Total Benefits	618	131.5	513.5	896.5	1,233.5	1,638.5		6,985

CHART B
BENEFIT SUMMARY
SYSTEM X UPGRADE
(000s OMITTED)

Alternative	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	TOTAL	Present Value Benefits
CURRENT	1,000	750	500	250	0	0	0	2,500	2,283
SHARED	618	131	513	897	1,233	1,639	1,954	6,985	5,004
CONVERSION	0	0	0	0	1,940	1,940	1,940	5,820	3,804

B. **Non-quantifiable benefits.** In addition to the benefits already described, significant non-quantifiable benefits were identified for the alternatives. These include:

(1) Increased Workload Capacity—The ability of the system to handle unanticipated workload increases and requirements without significant time delays.

(2) Increased Technological Capacity—The ability of the system to utilize future software enhancements without significant additional monetary outlay.

(3) Employee Morale—User perceptions that they are using the latest technology, which provides improvements over older equipment and increases interest and curiosity in the system. For some alternatives, morale may be reduced by the removal of local computers.

(4) Management Efficiency—As a result of faster data processing, reports and other relevant information can be made available more quickly, resulting in a more timely decision-making process.

(5) Access to Data—Along with the new system, there will be enhancements, which will allow supervisors to access information directly, rather than requesting it from a personnel office.

A committee of Department personnel was formed to evaluate non-quantifiable benefits. These personnel represented a sample of Department managers, supervisors, and System XYZ operating staff. Regional offices were also represented. Chart C shows the results of this process for alternative #2. (When preparing an actual report, include worksheets for all alternatives.) The committee members were first asked to rank each of the five benefits in order of importance. The individual rankings were combined to produce the ranking in column 1 of Chart C. The benefits were assigned weights representing the consensus of the committee on the relative importance of each benefit (column 3). The analyst then made a presentation describing each of the possible alternatives. Following the presentation, the committee members were asked to score the benefits for each alternative. A scale of 0 (no benefit) to 10 (maximum benefit) was used to score the benefits. The analyst calculated the average score for each benefit on all alternatives. These scores were multiplied by the benefit weight to provide a weighted score. The sum of the weighted scores provides the final score for each alternative. As shown in the following table, the total upgrade received the highest score from the evaluation. The total upgrade score (230) is approximately 10 percent higher than the shared upgrade alternative (206).

ALTERNATIVE	FINAL SCORE
Shared Update	206
Conversion	142
Baseline	100

CHART C

NON-QUANTIFIABLE BENEFITS

WEIGHTED RANKING CHART—ALTERNATIVE B—SHARED UPGRADE

Rank	Benefit	Weight	Alternative Score	Weighted Score
1	Management Efficiency	10	7	70
2	Increased	8	10	80
3	Access to Data	6	6	36
4	Increased Technological Capacity	4	5	20
5	Employee Morale	2	0	0

Total alternative score 206

III. COSTS

The results of the cost analysis of the three alternatives to meet System XYZ requirements are discussed below. Costs have been divided into three major categories:

Sunk costs;
Non-recurring costs; and
Recurring costs.

A. Sunk Costs. Sunk costs are expenditures resulting from past decisions. Sunk costs are not included in the comparison of alternatives since they would be the same for all alternatives. Prior to initiation of the BCA, the Department contracted with a consultant to produce a long-range plan for System XYZ. The cost of this study and associated Department costs were $14,485. In addition, the current support contractor was tasked to produce system requirements for planned enhancements and new requirements. This task cost $24,900. The total sunk costs for this upgrade are $39,385.

B. Non-recurring Costs. Non-recurring costs are those expenses required for purchase of new equipment and modification of existing software. These expenses are incurred only once at the beginning of the comparison period. Three different non-recurring costs were identified for this analysis: equipment purchase; system migration; and software modification.

1. **Equipment Purchase**

All equipment prices are based on price quotes from the General Services Administration (GSA). For the conversion alternative, the

estimated cost was based on an enhancement to the mainframe in the Department's computer center. The analyst developed a proposed equipment configuration for each alternative. For the total and shared upgrade alternatives, the analyst developed a list of required equipment by location. These lists formed the basis for the GSA price quotes. For the conversion alternative, the computer center staff developed an estimate of additional resources required to run System XYZ. This estimate was the basis for the GSA price quote.

2. **System Migration**

System migration costs are the expenses associated with physically replacing the existing computer equipment. In the past 2 years, the Department has replaced several minicomputers. While the same brand of equipment was not involved, the situations are similar enough to use those costs as a starting point. The average cost for the recent replacements was $4,625. The analyst added an additional $1,000 to the estimate to account for variations among locations and price increases. The price for each minicomputer replaced was estimated at $5,625. The costs for the conversion alternative were based on expanding the Department's computer center. Conversion of System XYZ would require addition of both central processing unit core and additional disk packs. Since the computer center has no additional room, an addition would be required. The facilities design and construction division provided a preliminary layout and cost estimate to build this addition.

3. **Software Modification**

Software modification covers the cost to modify current software to operate in the new computing environment. The shared and total upgrade alternatives assumed the same manufacturer would provide the new equipment. The current support contractor was asked to estimate the cost of moving the software to the new equipment. The contractor estimated an effort of 1.5 person-years. Using the current average cost per person-year ($50,000) under the current support contract, an estimate of $75,000 was used for software modification on these alternatives. For the conversion alternative, an estimate of $3,099,000 was developed. This estimate is based on an analysis using the Conversion Cost Model (version 4) of the Federal Conversion Support Center, Office of Software Development, General Services Administration. This model is considered to be a valid algorithm for generating conversion costs.

C. **Recurring Costs.** Recurring costs are the ongoing operating expenses of System XYZ. These costs are incurred throughout the comparison period. Three different recurring costs were identified in the analysis: training; telecommunications; and system support.

1. **Training**

Since the shared and total upgrade alternatives assume the same

operating environment (terminals, data entry screens, etc.), it was determined that there would be no system training cost. For the conversion alternative, it was determined that a 2-day training session would be required to instruct users in the new operating environment. The Training Division provided an estimate of $500 per person for an in-house course. This estimate was based on a similar course currently provided to System ABC users. Based on 250 active users, the cost of training is $125,000. This cost is included in year 3, under the assumption that training must be completed prior to implementation in year 4.

2. **Telecommunications**

Telecommunication charges are anticipated in the shared upgrade and conversion alternatives. These alternatives require many locations to link to a remote computer. In the shared upgrade alternative, they link to a minicomputer at another location. In the conversion alternative, they link to the mainframe at the computer center. Costs were developed using data provided by the computer center. The current cost for a leased line is $500 per month, or $6,000 per year. In the shared upgrade alternative, seven locations will require a leased line to process System XYZ transactions. In addition, the Department will require a leased line to transmit System XYZ updates to each installed minicomputer. The shared upgrade requires a total of eight leased lines at an annual cost of $48,000. For the conversion alternative, all 15 sites will require a leased line at an annual cost of $90,000.

3. **System Support**

System support costs are associated with the maintenance and operation of the System XYZ software. Currently, the Department contracts for this support through the computer center. This support is adequate for the shared and total upgrade alternatives since there will be no major changes to the system. Based on the computer center director's experience with similar systems, an estimate of five additional contractor staff would be required to support mainframe operation of System XYZ. This addition would include software support, computer operations, and telecommunications support. The total cost for this support was estimated at $200,000 per year. **SUMMARY.** The analyst completed cost analysis worksheets for each alternative. The cost worksheets were developed for all locations and summarized into a single worksheet for each alternative. The summary worksheet provides the total cost for the alternative in each year of the comparison period. Chart D shows the cost analysis worksheet for the shared upgrade alternative. Chart E summarizes the total costs for each alternative and provides the net present value of the costs. As shown in Chart E, the conversion alternative is 50 percent more expensive than the other alternatives. The costs for the remaining alternatives vary by less than 10 percent.

IV BENEFITS

The four alternatives were compared using both net present value analyses (NPV) and benefit and/or cost ratio (BCR). In this study, both the NPV analysis and BCR rank the shared upgrade alternative as the best choice. A summary sheet was prepared for each alternative showing the benefits and costs for each year in the comparison period. These were converted to present value using the average discount factor. Average discount factors were used because both costs and benefits are spread out over 12 months in each year. Chart F shows a summary sheet for shared alternative. Chart G shows the NPV and BCR for each alternative. The chart shows that the conversion alternative and the present system (baseline) are not economically desirable. On the other hand, both the shared and total upgrade alternatives appear to be desirable. Both have positive NPVs and BCRs greater than 1. The NPV of the shared upgrade alternative is $284,522 higher than the total upgrade alternative. This is a difference of approximately 37 percent. The BCR of the shared upgrade alternative is also clearly superior to all other alternatives. The total upgrade alternative was evaluated as marginally better than the shared upgrade alternative on non-quantifiable benefits. This difference is clearly outweighed by the higher NPV of the shared upgrade. Therefore, based on the analysis of benefit and costs, the shared upgrade alternative is clearly the recommended alternative. The cumulative benefits outweigh the cumulative costs at this point. The NPV of the conversion alternative is negative throughout the comparison period. This indicates that the benefits never equal the costs of this alternative. The graphs also show that the cumulative NPV of the current system is positive for the first several years of the period. This is due to the lack of equipment costs for this alternative. However, increasing maintenance costs and declining benefits cause the cumulative NPV to be negative by year 3. For the remainder of the comparison, the NPV of this alternative continues to decline.

V. COMPARISON OF COSTS AND BENEFITS

The data used to produce quantitative estimates of benefits and costs relied heavily on past experiences with similar systems. In addition, personnel cost avoidance estimates relied on the judgment of experienced managers. The analysis discusses what the BCA results would be if more pessimistic estimates of benefits and costs were used. The initial analysis indicates that the shared alternative is the most desirable of the alternatives. In order to test the sensitivity of this analysis to changes in benefits and costs, three possible scenarios were developed and analyzed:

- Reduce benefit estimates by 10 percent;
- Increase cost estimates by 10 percent; and
- A “worst case” scenario where benefit estimates are reduced by 10 percent and cost estimates are increased by 10 percent.

Both benefit and cost estimates rely to some extent on the judgment and estimates of Department staff. Given this source, the BCA team decided that a 10 percent overstatement of benefits and understatement of costs were a realistic possibility. (In the BCA team's judgment, these estimates were 90 percent reliable). The NPV of each alternative was recalculated after reducing benefits and increasing costs. In addition, a "worst case" scenario was analyzed where benefits were decreased and costs increased.

VI CONCLUSIONS

In this study, both the NPV analysis and the BCR rank the shared upgrade alternative as the best choice. Chart G shows that the conversion alternative and the present system (baseline) are not economically desirable. On the other hand, both the shared and total upgrade alternatives are desirable.

The NPV of the shared upgrade alternative is $284,522 higher than the total upgrade alternative. This is a difference of approximately 37%. The BCR of the shared upgrade alternative is also clearly superior to all other alternatives. The total upgrade alternative was evaluated as marginally better than the shared upgrade alternative on non-quantifiable benefits. This difference is clearly outweighed by the higher NPV of the shared upgrade. Therefore, based on the analysis of the benefits and costs, the shared upgrade alternative is clearly the recommended alternative.

Further, under all scenarios, the shared upgrade alternative is clearly superior. This reinforces the results of the basic BCA analysis.

VII RECOMMENDATIONS

The Department's payroll needs have outgrown the current computer-processing environment. The Benefit analysis and cost analysis results that it is more cost-effective and beneficial to implement the shared upgrade alternative (#2).

CHART D
COST ANALYSIS
ALTERNATIVE: B SHARED (000's Omitted)

Cost Category	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	TOTAL
Non-recurring costs								
Equipment Purchase	3,667							3,667
System Migration	45							45
Software Modification	75							75
Subtotal	3,787							3,787
Recurring Costs								
Telecommunications	48	48	48	48	48	48	48	336
Subtotal	48	48	48	8				
					48	48	48	336
TOTAL Costs	**3,835**	48	**48**	**48**	**48**	**48**	**48**	**4,015**

CHART E
COST SUMMARY
SYSTEM X UPGRADE
(000's Omitted)

Alternative	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total	Pre-sent Value Costs
CURRENT	763	763	763	763	763	763	763	5,341	4,250
SHARED	3,727	48	48	48	48	48	48	4,015	3,946
CONVERSION	4,316	466	466	591	466	466	466	7,237	6,544

CHART F
ALTERNATIVE SUMMARY
PROJECT: SYSTEM X UPGRADE ALTERNATIVE: B SHARED

Category	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	TOTAL
Total Costs	**3,727**	**48**	**48**	**48**	**48**	**48**	**48**	**4,015**
Present Value Costs	**3,727**		**42**	**38**	**34**	**31**	**28**	
Total Benefits	**618**	**131**	**513**	**897**	**1,233**	**1,639**	**1,954**	
Present Value Benefit	**618**							
Net Present Value	**(3,109)**							

CHART G
COMPARISON OF ALTERNATIVES
SYSTEM X UPGRADE

ALTERNATIVE	PRESENT VALUE COSTS	PRESENT VALUE BENEFITS	NET PRESENT VALUE	BENEFIT and/or COST RATIO
CURRENT	4,249,910	2,283,000	(1,966,910)	.54
SHARED	3,946,360	5,004,038	1,057,678	1.27
CONVERSION	6,544,120	3,804,340	(2,739,780)	.56