



WHITE PAPER

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COST ANALYSIS: BEST PRACTICES FOR COMPARING ALTERNATIVES

The purpose of this white paper is to communicate the criteria that the King County Auditor's Office (Auditor's Office) will use when evaluating cost analysis of alternatives. The section on guidance provides a list of components departments should identify when determining when and how to do cost analysis and includes additional guidance for analyses when the level of benefits is different among alternatives. The section on principles provides a list of technical components of analysis that can be useful to those conducting or reviewing cost analyses. There is also a list of definitions and sources at the end of this document. As the Auditor's Office reviews cost analysis of alternatives in the future, we will use the guidance and principles listed in this document as a starting point for our evaluation.

Guidance for Cost Analysis

Departments should provide clear and documented guidance for analysis conducted within their agency. Components that should be identified in departmental cost analysis guidelines include:

1. Specific criteria for which projects or program alternatives should be subject to formal life-cycle or cost-benefit analysis;
2. The position title of the person responsible for the analysis;
3. Thresholds that signal when analysis should occur or be updated to ensure the continued validity of selected alternatives, such as:
 - during early conceptual or planning stage of project development
 - at 30%, 60%, 90%, or 100% design, as appropriate
 - major decision points due to significant scope, schedule, and/or market changes that impact the availability and pricing of energy, materials, or other major cost components;
4. The level of detail that is appropriate at each of the thresholds;
5. Information that should be included in the analysis and where acceptable sources for detailed cost information can be found;
6. The minimum steps in the analysis, such as:
 - defining a set of feasible alternatives including a "status quo" alternative
 - defining the project completion date and estimate of useful life
 - developing cash flow estimates for each alternative
 - performing risk, uncertainty, and sensitivity analyses
 - comparing alternatives
 - selecting a preferred alternative, with documented reasons, to be recommended to decision-makers;

7. The methodology for obtaining or the value(s) of the major economic assumptions to be used in the analysis (e.g. discount rate, inflation rate, estimated useful lives) and any additional subject matter assumptions (e.g. solid waste tonnage, water usage, fuel costs);
8. A model template to be used by agency staff and consultants if the analysis and types of projects can use a standard model. The model template should be designed to allow for sensitivity analysis of major assumptions;
9. Instructions for how to use the model template;
10. A process for conducting and documenting the testing and periodic review of the model to ensure the analytical model is free of conceptual, technical, and human errors; and
11. Position title of the designated gatekeeper responsible for quality assurance to ensure that outputs of the analytical model are accurate.

Principles of Cost Analysis

The following nine principles represent best practices that, if followed consistently, address many of the concerns the Auditor's Office has identified in past performance audits of county agencies and programs.

1. **Analysis should include all of the estimated cash flows associated with each alternative over the estimated useful lives of the alternatives.** In some situations, initial analysis of alternatives can omit certain costs when those costs are the same and occur at the same time for each alternative. However, when results of the analysis lead to proposals to county decision-makers, the analysis should include full costs, and the results of the analysis should be expressed consistently in terms of net present values or annual equivalent costs. Analytical models should be constructed to display and compare full costs, not just differences.
2. **If the alternatives require full or partial financing, the model inputs should include the cash flows related to financing costs and debt service.** Analysts should conduct a sensitivity analysis showing model outputs assuming financing as well as out-of-pocket payment scenarios. Reporting the results of both scenarios highlights the impact of the county's relatively low (tax-advantaged) rate of borrowing and allows informed decisions about financing options.
3. **Cash flows for future years must be discounted to reflect the time-value of money.** A dollar today has a different worth than a dollar received or paid in the future.
4. **The time-value of when benefits are achieved should also be taken into account.** For example, when there are cumulative negative effects of pollution, an alternative that removes or avoids more of the pollution sooner has a different worth than an alternative that achieves the result later. As a practical matter, the calculation of the time-value of a non-dollarized benefit (such as metric tons of CO₂ reduction) can be done by discounting the unit cost of the benefit.

5. **When summing net present values that have been calculated in different years, the net present values should be expressed in same year or current year dollars by adjusting them by inflation, not by the discount rate.** For example, when comparing the cost of a product or service several years ago to the cost of the same today, the costs should be adjusted by inflation. By the same token, net present values expressed in previous years' dollars need to be inflated if compared to net present values expressed in today's dollars. This is particularly important if the net present values are to be summed.
6. **If the alternatives analyzed have different expected useful lives, a suitable methodology must be used for making a fair comparison.** This is because there is a benefit attached to assets that have relatively longer useful lives. Failing to take this benefit into account distorts the analysis. In many cases, such alternatives can be compared by calculating an annual equivalent cost or specifying a common endpoint for analysis¹. In no instance should an arbitrary cut-off be used for establishing the period of analysis.
7. **If costs and benefits are subject to different inflation rates, the analysis should be based on inflated cash flows and use the nominal discount rate.** This can occur, for example, in a situation where energy costs are escalating at a rate greater than labor costs, or when medical costs are escalating at a rate different from general inflation.
8. **If analysis or analytical models are constructed using the real discount rate, analysis should also be done using the nominal discount rate.** For any analysis, the net present values produced by either approach should be exactly the same. If they are not the same, there is a problem with one of the approaches. Conducting the analysis using both approaches is a way to check for such errors. Analysis that omits inflation and uses a real discount rate can be prone to errors due to failing to express all values in real terms consistently—for example the borrowing rate. Also, some analysis using the nominal approach can fail to inflate values appropriately. A model constructed to use inflation can be converted to a model without inflation by using the real discount rate and setting all inflation assumptions to zero.
9. **Reporting the outcome of the analysis should show the results of conducting sensitivity analysis on all major assumptions.** These should include key economic and financial assumptions, such as the discount rate, inflation rate, and useful life, as well as estimates of costs and benefits. Significant assumptions should be subject to sensitivity analysis even if they are based on a policy (for example, a discount rate policy). Conducting sensitivity analysis shows the effect of applying the policy choice and can highlight the level of uncertainty in the analysis.

¹ This is often referred to as the Replacement Chain or Common Life Approach, which assumes that each project can be repeated as necessary to reach a common life span; this method can be difficult and prone to errors if the projects need to be repeated many times to come up with a common life span.

Definitions

Annual Equivalent Cost refers to a way of expressing a net present value as an annual cost. Using annual equivalent costs is a practical way of comparing alternatives that have different useful lives. Annual equivalents are calculated by determining an annual cost that if carried forward each year would produce the same net present value over the same period of analysis as the actual varying cash flows of the project.

Cost-Benefit (or Benefit-Cost) Analysis helps users determine whether a project or policy option is desirable based on a quantitative assessment of future effects and potential side effects.

Discount Rate refers to the interest rate used to convert future values to present values, taking into account the time-value of money of the people on whose behalf an investment decision is being made. The *nominal discount rate* includes the effects of inflation; whereas the *real discount rate* removes the effects of inflation. If the borrowing rate is used as the discount rate, then by definition the borrowing rate is a nominal rate because borrowing rates are affected by inflation.

Life Cycle Cost Analysis helps users compare alternatives over the life of the project or program by assessing all costs and financial benefits over this period: initial, periodic, and continuing costs of operation and maintenance, revenues, and other financial benefits (e.g. avoided costs).

Net Present Value (NPV) is an amount that indicates to users whether the future costs and benefits of something “pencil out” in terms of today’s dollars. The NPV is found by discounting future costs and benefits using an appropriate discount rate and then subtracting the discounted costs from the discounted benefits.

Sensitivity Analysis refers to changing assumptions within a reasonable range to see how the outcome of the analysis differs when those changes are made. The assumptions that merit the most attention are usually those that have the largest effect on the comparison of the alternatives and those that are most likely to change.

List of Sources

U.S. Government Accountability Office, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C., 2009) <http://www.gao.gov/new.items/d093sp.pdf>

U.S. Office of Management and Budget, *Circular A-94: Guidelines and Discount Rates for Benefit-Cost Analysis of Federal programs* (Washington, D.C., revised 2014) <https://www.whitehouse.gov/sites/default/files/omb/assets/a94/a094.pdf>

Zerbe, Richard O., and Dwight Dively. *Benefit-Cost Analysis in Theory and Practice*. New York: HarperCollins College Publishers, 1994.

Note: This document summarizes criteria as defined by the Generally Accepted Government Auditing Standards (2011) 6.37 and A6.02. It has been traced and verified by the King County Auditor’s Office and reviewed by the King County Office of Performance, Strategy and Budget.