Department of the Army
Pamphlet 415–3

Construction

Economic Analysis: Description and Methods

Headquarters
Department of the Army
Washington, DC
28 September 2018

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SUMMARY of CHANGE

DA PAM 415–3
Economic Analysis: Description and Methods

This major revision, dated 28 September 2018—

- Adds the Army Family Housing Construction to the military construction process (para 1–1).
- Introduces the certification of an economic analysis in programming administration and execution system (para 1–5*a*).
- Defines the dollar threshold for preparing an economic analysis (para 1–6).
- Expands on the overseas guidance (paras 2–5*a* through 2–5*c*).
- Expands on the economic analysis process (chap 3).
- Defines cost elements for Army Family Housing Construction (paras 5–4*a* through 5–4*c*).
- Defines incremental costs for Army Family Housing Construction (paras 5–7*a* through 5–7*d*).
- Defines sensitivity analysis for Army Family Housing Construction (paras 7–5*a* through 7–5*k*).
- Expands on the review and certification process for economic analyses (chap 8).
- Incorporates Army Family Housing Construction reporting requirements (app B).

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Construction

Economic Analysis: Description and Methods

By Order of the Secretary of the Army:

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History. This publication is a major revision.

Summary. This pamphlet presents guidance for performing economic analyses as part of the resource allocation process for Military Construction, Army; Base Realignment and Closure, Army; Commercially Financed Facilities; Army Family Housing Construction; Army Reserve; and Army National Guard projects. This information clarifies the Army policy on economic analysis by DODI 7041.3 and OMB Circular A–94. Results of an economic analysis provide valuable input in deciding which projects to fund for the most cost–effective use of tax dollars. In addition to providing instructions for conducting an economic analysis, this pamphlet contains guidance for reporting.

Applicability. This pamphlet applies to the Regular Army, the Army National Guard/Army National Guard of the United States, and the U.S. Army Reserve, unless otherwise stated. Also, it applies to sub installations and assigned activities.

Proponent and exception authority. The proponent for this pamphlet is the Chief of Engineers. The proponent has the authority to approve exceptions or waivers to this pamphlet that are consistent with controlling law and regulations. The proponent may delegate this approval authority, in writing, to a division chief within the proponent agency or its direct reporting unit or field operating agency, in the grade of colonel or the civilian equivalent. Activities may request a waiver to this pamphlet by providing justification that includes a full analysis of the expected benefits and must include formal review by the activity's senior legal officer. All waiver requests will be endorsed by the commander or senior leader of the requesting activity and forwarded through their higher headquarters to the policy proponent. Refer to AR 25–30 for specific guidance.

Suggested improvements. Users are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publications and Blank Forms) directly to the Chief of Engineers, (CECW–EC), 441 G St. NW, Washington, DC 20314–1000.

Distribution. This regulation is available in electronic media only and is intended for the Regular Army, the Army National Guard/Army National Guard of the United States, and the U.S. Army Reserve.

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*This pamphlet supersedes DA Pam 415-3, dated 10 August 1992 and rescinds DA Pam 210–6, dated 8 October 1990.

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Chapter 1
Introduction

1–1. Purpose

a. This Department of the Army (DA) pamphlet (PAM) supports installation analysts in understanding and developing economic analyses (EAs). It explains how to conduct EAs in support of military construction Army (MCA), Base Realignment and Closure (BRAC), military construction Army Reserve (MCAR), military construction National Guard (MCNG), and Army Family Housing Construction (AFHC) projects and how to report results. It does not apply to Productivity Capital Improvement Program, Energy Conservation Investment Program or any other analysis type not specifically listed above. Office of the Secretary of Defense (OSD) guidance on economic analyses for privatized housing and lodging is contained in the Department of Defense (DOD) 4165.63–M.

b. This pamphlet provides enough information that an entry level analyst will be able to use it as a reference to perform EAs for MCA; BRAC, MCAR; AFHC, and MCNG projects. In this document, MCA and BRAC are denoted by military construction (MILCON). (MILCON is a compound word of the words military and construction.) It describes the complete economic analysis (EA) process and the analytical tools needed to perform EAs, as well as essential data and reporting requirements. This document will be useful to all persons involved in the EA process, from those who assist in providing data to be included into the EA, to those who make decisions using results of the EAs. Entry level persons may require close supervision when undertaking tasks as part of the EA process, whereas journeymen and supervisors should be formally trained in EA.

c. All methods required to perform an EA for the MILCON process are provided in this document. It is self-contained in that the complete process of preparing an EA is described in detail with explanations of terminology, equations, and reporting elements. Although the report is directed toward the Major MILCON process, the basic EA procedures can be used for any EA.

1–2. References and forms

See appendix A.

1–3. Explanation of abbreviations and terms

See glossary.

1–4. Military construction approval process

It is necessary to view the EA in the context of the MILCON project approval process since, ultimately, the EA serves as part of the project justification. In fact, the EA is a key element of the justification required to obtain MCAR, MCNG, MCA, AFHC, and MILCON funding.

a. The requirement for a project is normally identified by the user at the installation. This requirement is documented in the Department of Defense (DD) Form 1391 (Fiscal Year or FY, Military Construction Project Data) and submitted to higher command levels for approval. The DD Form 1391 will either be completed by the installation or at their behest, by USACE Districts/Centers, and/or private firms. Copies of the completed DD Form 1391 are submitted to U.S. Army Corps of Engineers (USACE), U.S. Army Information Systems Engineering Command (USAISEC), and U.S. Army Installation Management Command (IMCOM) for review.

b. Chief, Army Reserve or Chief, National Guard Bureau (NGB) reviews EAs for their respective MCAR or MCNG projects in lieu of IMCOM, which reviews MCA. Project DD Form 1391s on U.S. Army Materiel Command (AMC) installations are submitted for review through the respective major subordinate commands (MSCs) to AMC Headquarters (HQ) for program objective memorandum (POM) development and, when required, through the Programming, Administration and Execution System (PAX) hierarchy to IMCOM.

c. Comments are submitted to respective Land Holding Command (LHC), Office of the Chief, Army Reserve (OCAR), or NGB by USACE and USAISEC. The LHC, OCAR, or NGB compiles the comments making the necessary changes and submit the completed DD Form 1391 to Office of the Assistance Chief of Staff for Installation Management (OACSIM) (where projects will be reviewed by MILCON stakeholders and Headquarters, Department of the Army (HQDA)), OSD, Office of Management and Budget (OMB), and congressional levels (see fig 1–1 and AR 420–1).

1–5. Timeline for average military construction project

A depiction of the timeline for the average military construction project is shown in figure 1–2.

a. Each EA must be submitted to the attention of the USACE Economist Reviewer for review and approval prior to consideration of the project by the MILCON Integrated Programming Team (IPT). Upon acceptance of the EA by the USACE Economist Reviewer; the PAX will be annotated to reflect acceptance under the EA Certification function.

b. Lack of a proper EA in support of projects can result in deferral or elimination of the projects from the MILCON program and a loss of DA MILCON funding for the fiscal year (FY).

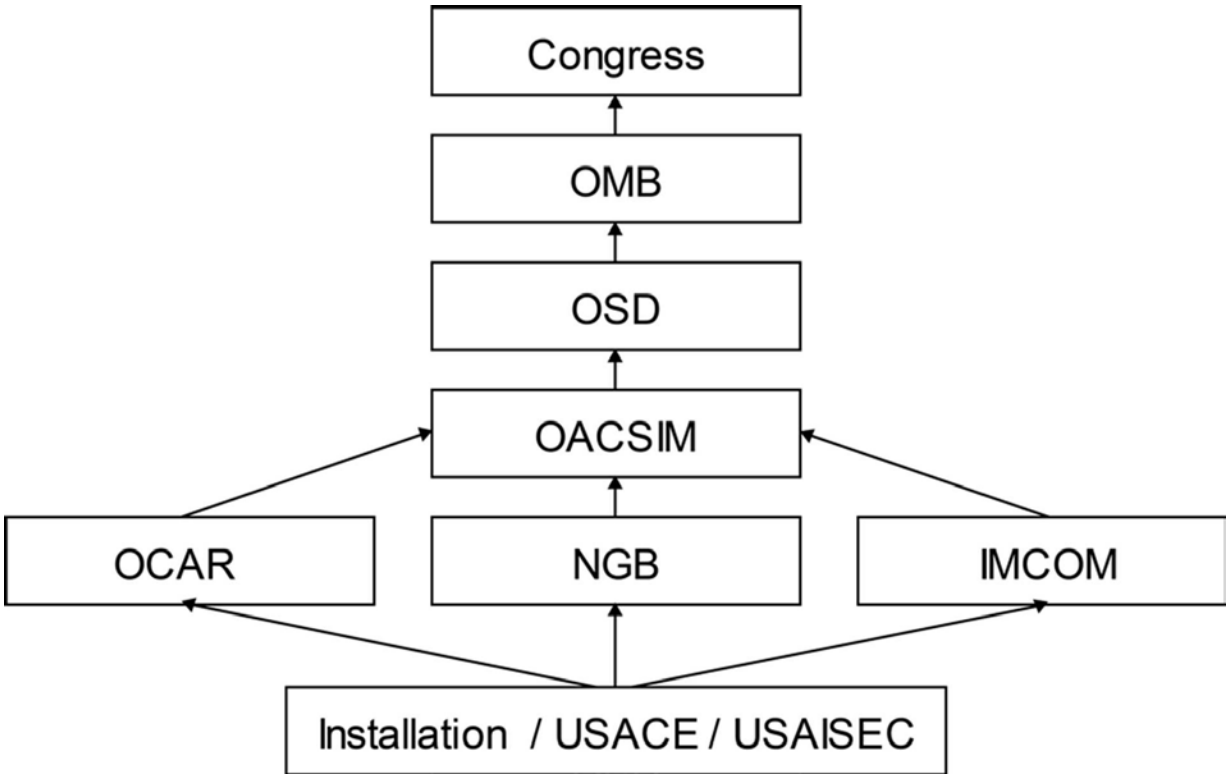


Figure 1–1. Project review process

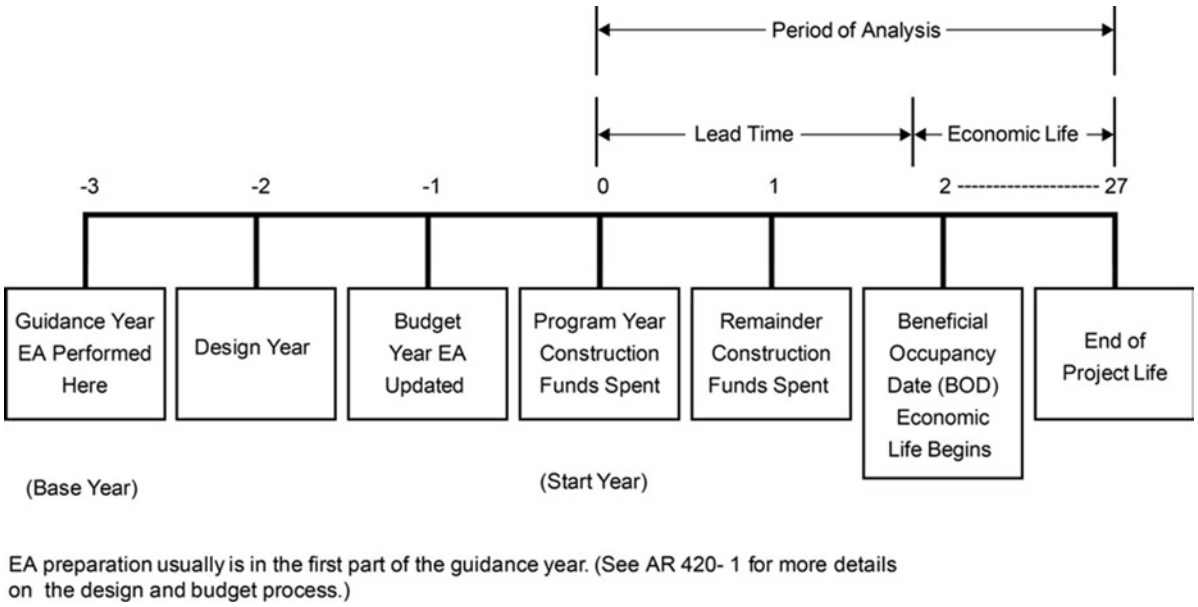


Figure 1–2. Relationship among key dates for a typical military construction

1–6. Requirement for an economic analysis military construction appropriations

a. Whenever you exceed the localized maximum threshold to qualify for a Minor MILCON project, then you must have an EA since the project now becomes a Major MILCON project. According to National Defense Authorization Act FY18, (NDAA FY18) increases Unspecified Minor Construction, Military Construction Army (UMMCA) thresholds from $2M to $6M and allows for increase of threshold by area cost factor (ACF) up to a maximum of $10M within the United States territories, commonwealths and possessions and $6M overseas. For example, project A at a U.S. location with ACF=1.5 would have a maximum threshold of $6M x 1.5 = $9M. Use Unspecified Minor, Military Construction Army (UMMCA) project A at U.S. location with ACF=2.0 would require major construction for full scope ($6M x 2.0 = $12M which exceeds $10M threshold) project A at U.S. location with ACF= 0.85 would have a maximum threshold of $6M. Use UMMCA. This puts the threshold for preparing a MILCON economic analysis at $6M to 10M and overseas at $6M.

b. There is only one exception to the requirement to perform an EA: when proposed actions are specifically directed by legislation, which included a legislative mandate specifying an exemption to the requirement for an EA. In other words, the legislative action must include, not only the directive to engage in a project, but a very specific mandate as to how the requirement is to be provided and a waiver to the need to assess any alternative course of action.

c. An EA can be completed at any point prior to the commencement of the planning charrette (PC), when required, and the development of a DD Form 1391. Generally, the requirements analysis, a precursor of the PC and the DD Form 1391, includes an analysis of alternatives (AoA). The AoA completed in support of the requirements analysis should be used to complete the tab D (in PAX), EA for the DD Form 1391. A DD Form 1391 programming document is required for every MILCON project that seeks chain of command approval and budget submission. The DD Form 1391 contains multiple tabs including the EA justification, which is documented in tab D (Economic Analysis). (See AR 420–1 for additional information regarding DD Form 1391 project submission.)

d. The Planning Charrette is a tool that uses an interdisciplinary perspective to prepare DD Form 1391 documents. When required, the PC deliverables include preparation of the narrative portion of project justifications, development of programming level construction cost estimates, and preparation of economic analyses. The determination of whether the PC is required depends on which command develops the DD Form 1391. A planning charrette is required for all USACE-produced DD Form 1391 documents. Although recommended, some installations may not require a planning charrette when developed in-house.

1–7. Economic analysis versus budgeting

Economic analysis and budgeting are completely separate processes.

a. The EA is used to help determine the best alternative to meet an Army requirement as specified in the project objective. Data presented in the EA may or may not be useful in a future budget process. An EA may contain costs which are the responsibility of several different organizations, making it difficult to use them in the budgeting process for a single element.

b. Project costs included into an economic analysis may come from different budgets (operations and maintenance costs versus construction costs). There may also be costs which are included in the project budget but do not appear in the EA. For example, wash costs are not included in an economic life-cycle analysis, but must be included in the budget. Also, the time basis of EA costs may differ from that of the budgeting process.

c. The EA estimates the net present value (NPV) of each cost to equate the value of the alternatives, while budgets specify only current dollar amounts to be expended in the future.

Chapter 2
Concepts, Goals, and Steps of Economic Analysis

2–1. Description of economic analysis

a. Economics is defined as the study of unlimited wants in an environment of limited resources. In reference to MILCON projects this definition denotes a funding limitation. At any one time the Army has insufficient resources available to fund all its projects.

b. At all levels a project must compete for limited funding. Not only must the Army balance its own internal requirements against other funding requirements (munitions vs. equipment vs. medical expenses, and so on), the Army also faces competition for limited funds from other services and agencies. Every dollar allocated to the Army and which the Army further allocates to facilities projects will be subjected to competition amongst facilities related projects: obtaining facilities to meet new mission requirements, replacement of aging or functionally obsolete structures or renovation of structures.

c. Decision makers must be confident that a given project represents the most economic and beneficial course of action to provide for a given need. In other words, the decision maker must be confident that the project as presented represents the "most bang for the buck". The best solution among all possible alternatives is identified and selected by performing an EA.

d. Decision makers utilize economic evaluations to help them formulate and support projects.

e. All possible choices for satisfying a given requirement, problem or need must be assessed to verify viability of each alternative (see para 3–2).

f. Viable alternative means of satisfying a given requirement, problem or need are studied by evaluating the quantifiable costs and qualitative or intangible costs and benefits of each alternative (see para 3–1, steps 3 through 7).

g. An EA analyst uses a standard method to organize and present elements of an economic study so that:

(1) Informal thinking is focused and clarified.

(2) Hidden assumptions are found, discussed, and their impacts studied.

(3) Information is reported in simple, concise terms for use in recommendations and project funding decisions.

2–2. Goal of economic analysis

The ultimate goal of an EA is to provide a recommended course of action. An EA is one of several decision criteria; it is not the only factor used by the decision maker. The recommended course of action must be supported by an unbiased, systematic, financially sound and comprehensive analysis.

a. Used correctly, the EA methodology specified here should result in an objective assessment of all costs, benefits, and uncertainties of various alternative methods of providing for a given need.

b. The EA must promote a clear understanding of the stated need, possible solutions, and cost implications of various alternatives. All EAs should exemplify a rational approach for allocating scarce resources efficiently.

c. An EA allows an analyst to compare multiple alternatives having unequal cost streams in order to identify the least cost alternative. The least costly alternative is usually the preferable alternative but not always. In some instances, impacts of non-monetary benefits will out weight financial considerations resulting in the selection of an alternative other than the least cost alternative. In most cases, the ultimate goal is that tax dollars are spent most economically. Proper use of this methodology will identify the least cost alternative and support the efficient allocation of scarce funding resources in the MILCON program.

d. Justification for any course of action must be supported by a complete accounting of all viable alternatives to include analysis of the costs and benefits of those alternatives to arrive at the most beneficial solution.

e. EA of housing alternatives are conducted with a little more regulation than standard economic analyses. The process is similar, but requires a little more guidance. Throughout the pamphlet, requirements specific to evaluating housing alternatives will be noted. Economic analysis of housing alternatives must consider the following processes:

(1) Identify the need for housing resources by referring to the most recent housing requirements survey. This survey should not be more than 1 year old. It must be based on the projected post strength and it must be supported by a Housing Market Analysis (HMA), which demonstrates that the private rental market cannot provide the dwelling units (DUs) that are the subject of the economic analysis. HMA is also known as Housing Requirements and Market Analysis (HRMA).

(2) Design housing alternatives in response to housing needs, housing market features, command choices, and special rights (prerogatives).

(3) Identify all reasonable alternatives excluding those that cannot solve the housing problem.

(4) Identify all cost kinds relevant to each alternative to be analyzed.

(5) Identify all cost elements relevant to each cost kind for each alternative.

(6) Prepare a cost element matrix, marking each line only for those alternatives that contain exactly the same types of operating characteristics and costs.

(7) Identify and document wash costs.

(8) Collect cost, inflation, and other data needed to complete the economic analysis.

(9) Compute total cost and other needed statistics in economic analysis package (ECONPACK). (See para 2–6 for additional information.)

(10) Prepare documentation in accordance with chapter 5. Sources of cost and other estimates must be thoroughly documented. All calculations must be documented to inform reviewers that analyses were performed appropriately, and that the calculations were structured correctly.

Note. Contact OACSIM Housing (DAIM–ISH) for assistance with creating a statement of work. OACSIM, (DAIM–ISH), 600 Army Pentagon, Washington, DC 20310.

2–3. Determine the scope of an economic analysis

The scope of an EA is determined by any number of factors which are particular to a given project. Generally, these various factors can be classified into one of four broad categories: constraints, area of influence of the requirement, availability of existing resources, and physical constraints.

a. Constraints. A constraint is defined as guidance, physical or legal constraint which imposes a limitation precluding a possible alternative course of action. Examples of the some of the more common constraint factors include:

(1) *Facility collocation.* Some of the standard designs for facilities complexes such as the basic training and one station unit training (BT/OSUT) Complex contain adjacency requirements designed to limit the amount of time spent moving troops between training venues. For example, the distance between the barracks and company operations facility (B/COF) to the dining facility (DFAC) can be no greater than 1,680 feet. A list of standard designs for various facility types can be found at https://mrsi.erdc.dren.mil/cos/standard-designs/.

(2) *Anti-terrorism/force protection*. Anti-terrorism/Force Protection (AT/FP) standoff distances are referenced in Unified Facility Code (UFC) 4–010–01. For example, if the project need being analyzed is for a company operations facility (COF) building and the only available site for new construction doesn't include enough acreage to site the building inclusive of the appropriate minimum standoff distances, then the new construction alternative can be dismissed, provided hardening is discussed.

(3) *Location of facilities on-post*. There are certain facility types, which cannot be located off a military installation. These are facility types which are either not found within the civilian market or which have a mission the conduct of which must be secured. Examples of these types of facilities include ranges, arms vaults, tactical equipment maintenance facilities (TEMF), and so forth.

(4) *Legal constraint*. The Government can impose constraints upon itself, which limit or prohibit utilization of a facility or piece of land. If a possible alternative were to violate any piece of guidance which limits use of a building or piece of land, then the alternative is classified as non-viable and removed from consideration. Classification of an alternative as non-viable due to violation of a guidance constraint must include a reference to that guidance document and an explanation of violation.

(5) *Distance*. Proximity of facilities to Soldiers home of record for Reserve Component and Reserve and Readiness Centers. For example, if the distance from the existing facilities to the alternative site being considered is outside of a 50 mile radius or more than a reasonable commuting time of one and one-half hours during average traffic and weather conditions then the new construction or lease alternative can be dismissed.

b. Area of influence. The scope of an EA will depend on the area of influence of the requirement being analyzed. In most cases, the alternatives being considered will be confined to a single location on an installation. However, even though

the project will have a preferred site location some projects may require the consideration of multiple site locations on an installation or may require consideration of site locations outside the fence line. Alternative sites within the installation will entail differences in project costs due to differences in utility connection points in proximity to the project site. As a result, each alternative site will require the development of a standalone alternative. Likewise, the consideration of alternative sites outside the fence line will require the development of individual alternatives for each site being considered. For projects where the square footage need is relatively small or where the mission being considered can be accommodated in various facilities, the analyst should expect the development of additional alternatives.

c. Availability of existing resources. Several of the standard alternatives focus on the re-use of existing assets: status quo facilities, renovation of status quo facilities, renovation/new construction of status quo facilities, use of other facilities on the installation, use of other DOD or Federal agency facilities. If the installation on which the project will be sited contains a number of facilities, which are not being utilized, then the analyst should expect the development of additional alternatives.

d. Physical constraints. When a facility lacks the physical space for renovation/new construction mix due to occupied space by another in use facility; proximity to restricted land use (environmental guidance); utility lines impact rail lines; distance grater then 50 miles or 1.5 hours from the installation; and so forth.

2–4. Concise guidelines for performing economic analysis

EA development consists of nine basic steps. A brief overview of each of these steps is given in paragraph 2–4 while chapter 3 contains a detailed discussion of each step.

a. Step 1: Establish project objective. The project objective is a problem statement, which defines the need the Government is attempting to answer. The reason for undertaking an EA is to discern the most beneficial means of achieving a solution to a perceived problem. The project objective must be an unbiased statement of the problem, or project need. The project objective should not contain any word or phrase which denotes a conclusion of the analysis or a preference for one alternative over another. The presence of words such as "construct", "build", "renovate", or "lease" and all others denoting a specific method of achieving a solution to the problem are prohibited. The project objective should also include a list of all primary facilities being analyzed, a measurement or quantification of that need and a list of any constraints upon the project. The project objective must never include costs or assumptions about costs as a constraint.

b. Step 2: Identify alternatives. There are twelve standard alternatives that must be addressed in the EA. (See paragraph 3–2, for a full discussion). At this stage, analysis of each alternative should focus on establishing the viability of the alternative against the project objective. Alternatives that meet the need of the project objective are classified as viable. Alternatives that do not meet the need as specified in the project objective are classified as non-viable. An alternative cannot be classified non-viable based on the opinion of the analyst or on prohibitive costs. Options can only be deemed non-viable if there are judicial (regulations or public laws) or physical constraints prohibiting the alternative.

c. Step 3: Classify economic analysis. There are three classes of economic analyses: nominal, partial (single viable alternative) and full (multiple viable alternatives). A nominal economic analysis is a highly specialized instance where Congress has enacted legislation (Public Law) which includes a directive to engage in a project, a very specific mandate as to how the requirement is to be provided and a waiver to the need to assess any alternative course of action. This is NOT a congressional add. When step 2 produces a partial (single viable alternative), it is necessary to document steps: 1, 2, and 9 according to chapter 3. When step 2 produces a full (multiple viable alternatives), it is necessary to comply with and document all steps of chapter 3. There are two types of full economic analyses: a mission requirement analysis and a return on investment (ROI) analysis. Succinctly, a mission requirement analysis is one which analyzes various means to provide for a new requirement and an ROI analysis is one which analyzes more efficient means of providing for an existing requirement, which will reduce the current budget.

d. Step 4: Formulate analysis. A full life-cycle cost analysis is a complex undertaking which requires the analyst to account for all variables to 1) establish the total cost of an alternative, 2) inflate or deflate those costs accordingly, and 3) compare each alternative against all other viable alternatives. The analyst will need to formulate a data requirements list with the assistance of project stakeholders, to arrive at a list of cost categories.

e. Step 5: Define assumptions. An assumption is a simplifying mechanism whereby a variable(s) having a small or minimal impact on the outcome of the analysis is assigned an educated or assumed value. Assumptions should only be made when the effort to calculate the value of a variable would require a significant amount of time with the results having little or no impact on the outcome of the analysis. The impact of assumptions can be tested later in sensitivity analyses.

f. Step 6: Perform life-cycle cost analysis. The analyst must estimate costs and benefits, develop source documentation, and compare costs and benefits.

g. Step 7: Determine non-monetary considerations. Not all costs and benefits of a project can be expressed in monetary terms. Impacts on health and welfare, morale, safety, command and control, and training effectiveness are important con-

siderations to the total effectiveness of a proposed alternative. In some cases, the impact of a project solution to a nonmonetary consideration may override selection of the least cost alternative. Non-monetary impacts must be accounted for in the EA.

h. Step 8: Perform sensitivity analyses. A sensitivity analysis is a "what-if" exercise. It tests whether the conclusion of an EA will change if some variable such as a cost, a benefit, or the discount rate changes. At a minimum a discount rate sensitivity analysis must be performed and documented. A cost sensitivity analysis should be performed when two alternatives are close in NPV totals ($3M or less) and when any project cost item which exceeds 20 percent of the total project cost must be tested for sensitivity. The results of both the discount rate and cost sensitivity analyses are to be documented in the results and recommendations statement.

i. Step 9: Report results and recommendations. A conclusive statement, which compares and ranks the various viable alternatives and specifies the recommended course of action needs to be included into the EA. This section of the EA will also include the results of the sensitivity analyses. Based on the conclusion reached, the analyst needs to select the appropriate statement (in PAX) for insertion into the "Additional Paragraph" of tab A of the DD Form 1391 (see para 3–9).

2–5. Guidance for overseas commands and installations

Overseas commands and installations encounter several sets of unique problems different from those in the continental United States (CONUS), Hawaii, and Alaska.

a. The options may be very limited due to host country restrictions, status of forces agreement (SOFA), Host Nation Funded Construction Agreements (HNFA), Bilateral Infrastructure Agreements (BIA) and U.S. laws which may limit MILCON or leasing opportunities outside continental United States (OCONUS). In general, if multiple agreements are in place, the most stringent of those agreements must be applied. Site specific limitations or constraints imposed on construction of OCONUS projects should be defined in the background section, and where applicable, listed as a reason for exclusion of an alternative.

(1) In OCONUS locations where a SOFA, HNFA or other agreement is lacking, facilities may be classified as semi-permanent as opposed to permanent property. (For a definition of construction types see Unified Facility Code, UFC 1–200–01 section 1–3.) The classification of a facility or building as semi-permanent changes the standard of design to the Austere or Contingency standard. Austere or Contingency standards are the purview of the Middle East District and can be found at https://mrsi.erdc.dren.mil/cos/tam/.

(2) For Host Nation Funded projects, in accordance with DOD 7000.14–R, Volume 2B, DOD Directive (DODD) 2010.5, components are required to indicate on the justification page for each individual construction project for U.S. forces committed to North Atlantic Treaty Organization (NATO) a statement whether or not the project is planned for pre-financing, with appropriate explanation as to: (a) why U.S. unilateral financing is being proposed; and (b) as appropriate, follow-on actions planned to seek reimbursement through NATO channels. A similar statement is required for any other overseas construction, describing why the project is not eligible for host nation funding. More specific guidance is provided in DODD 2010.5. The DODD directs that the U.S. Government will attempt to recoup funding spent on NATO projects through payment in kind (PIK) projects or other types of reimbursement. This measure is so aggressive that construction of a facility can be stopped to account for the advent of NATO funding: "If NATO funds become available during project construction, U.S. funds shall be promptly de-obligated."

(a) In reference to PIK projects, there is a requirement in DOD Instructions (DODI) 4165.69 to recover the residual value of U.S. funded improvements at realigned sites or OCONUS sites. The guidance stipulates that the U.S. Government can accept PIK in place of a residual value cash payment when certain circumstances are met. So the residual value of the facility, the estimated cost savings of the realignment, and the value of the PIK must be assessed.

(b) The above requirement does not, in and of itself, require the analyst to engage in a full life-cycle cost analysis of host nation versus U.S. funded projects at OCONUS sites. Host Nation funded is not to be regarded as a project alternative but rather a funding alternative.

(c) However, in cases where OCONUS projects are funded using U.S. rather than host nation funds, there is a potential future need to account for the residual value of that project. This residual value calculation being an input into a PIK analysis, it may be advisable to engage in a full life-cycle cost analysis of a project at an OCONUS site. The analyst should coordinate with the project proponent to assess the need for this level of analysis.

b. Exchange rates for foreign currencies fluctuate greatly and their future values are difficult to estimate. However, it is not necessary for the analyst to expend effort in attempting to forecast currency fluctuations for inclusion into the EA. The Programming Administration and Execution (PAX) System assumes that the selected exchange rate will remain constant over the analysis period and has hardcoded these exchange rates into the DD Form 1391 processor. Exchange rate factors are published annually in PAX Newsletter "DOD area cost factors (ACF)" and are updated annually. Fluctuations in exchange rates which deviate from these assumed values and which impact construction costs are handled via a Centrally Managed Allotment (CMA) (see DFAS–IN Regulation 37–1).

c. Foreign inflation rates are much different than those in the United States. An attempt should be made to factor inflation into the calculations of costs for each alternative. Most industrialized nations publish Government produced inflation rates; if one can be found that is specific to construction, it should be utilized. A few suggestions for sources of local inflation rates are to check with your local Resource Management Office or an index of the most recent inflation rate can be acquired from the Central Intelligence Agencies World Fact Book or the European Commission, Eurostat Home Page, Economy and Finance.

2–6. Computer programs for economic analysis

a. Proper preparation of an EA requires a major effort to gather necessary data, to perform the requisite mathematical calculations, and to summarize results into required report formats. Use of the Government mandated computer program, ECONPACK, will reduce the time required to complete an EA, ensure correct calculations, and produce results that comply with DOD and Congressional guidance. The ECONPACK program is available for downloading by means of the MILCON PAX System. ECONPACK is a personal computer program that allows the computer user to input information and upload the completed work to the PAX System. This allows analysts the freedom to construct the EA as information is made available. ECONPACK is data intensive and requires manual user input; valid data must be used to ensure effective results.

b. The personal computer program allows automatic copying of the EA results to the DD Form 1391, which is required before the DD Form 1391, is submitted for higher level review and approval. Information about these programs can be obtained from Headquarters, U.S. Army Corps of Engineers (HQUSACE) or PAX Support Team, Corps of Engineers–Huntsville Center (CEHNC).

Chapter 3
Economic analysis process

The nine steps which comprise the full (multiple viable alternatives) EA process are shown in figure 3–1 and discussed in detail below. If chapter 3, step 2 produces a partial (single viable alternative), it is necessary to document only chapter 3, steps 1, 2, and 9 according to the instructions in this chapter. If an economic analysis is precluded by direction of Congress, according to the criteria as stipulated below in paragraph 3–3*a*, state that an economic analysis is not required, cite the actual language of the law and Public Law number, which precludes an analysis and document any additional pertinent information accordingly.

3–1. Step 1: Establish project objective

a. A proper project objective must be a clear, concise, and unbiased statement of project need.

(1) Used in this context, bias is defined as the use of any word in the project objective, which suggests a preference for any one of the standard alternatives specified below. Statements such as: “to construct”, “to renovate”, “to lease” or any other such statements inject bias into the project objective. An improperly stated project objective may indicate that the EA was done to justify a pre-existing conclusion and not to determine the most economical solution for a requirement. To ensure against bias, the project objective should always be stated: “To provide”.

(2) To ensure a clear and concise statement of need, the project objective should be limited to three components:

(a) A list of all primary facilities to be analyzed. Supporting facilities or infrastructure should not be listed.

(b) A measurement or quantification of the proposed facility being analyzed. Reference DA PAM 415–28 and https://www.acsim-apps.army.mil/ for the applicable unit of measure for each facility analyzed.

b. A list of any externally mandated constraints, which might preclude an alternative from consideration. Definitively, an externally mandated constraint is a piece of guidance, legislation, or regulation which specifically forbids a certain practice (see section 2.5 a Constraints). Constraints, which are common to all facility types, need not be stated. Compliance with AT/FP, leadership in energy and environmental design (LEED) or low impact development (LID) requirements do not need to be specified. In contrast, a signed command directive which requires a function to be located on post needs to be stated as a limitation, host country legislation forbidding a certain act or construction type, or a directive not to lease certain types of properties needs to be stated. For example, consider the following two project objectives both of which are for the same facility:

(1) To provide 35,000 square feet of central issue facility space to store materials and equipment issued to basic training Soldiers. Basic training Soldiers must remain on post for the duration of their training, this facility must be located on post.

(2) Construct a general warehouse building with an area of 35,000 square feet.

c. The first states a project objective in unbiased terms, includes a measure of the project need and any limitations, which may preclude consideration of an alternative.

d. The second is biased toward constructing a new facility. This project objective does not contain the correct facility type description. Although the second statement contains a measure of the project need, it does not contain the required limitation.

e. The wording is critical in stating the project objective. The project objective will be centrally reviewed for compliance against the criteria stated in this document (see para 8–1).

f. In addition to the above requirements, Army Family Housing during development of the project objectives, it is likely that the analysts will discover needed and important additions to the definition of the problem. When this happens, the objectives should be modified and their development refined. Examples of selection criteria are as follows:

(1) Minimizing costs.
(2) Providing housing for a specific number of Families.
(3) Keeping commuting time within 1 hour and the commuting distance within 30 miles.
(4) Providing a distribution of units with 0 (studio), 1, 2, 3, 4, and 5 or more bedrooms.
(5) Meeting Army standards for housing Soldiers and their Families in various grades.
(6) Operating under control of the Army (or not).
(7) Freeing tenants from dealing with host country landlords.
(8) Reducing the amount of money service personnel must pay for quarters.
(9) Increasing the number of accompanied (longer) tours.

3–2. Step 2: Identify alternatives

The next step provides a discussion of each of the twelve standard alternatives listed in 3–2*d*. Until the objective has been defined it is impossible to select a course of action (alternative) that may satisfy the nonexistent objectives.

a. Having a broader firsthand knowledge of the project, the analyst will be able to dismiss quickly some alternatives as nonviable solutions. This does not preclude the inclusion of a detailed discussion of that alternative. It should be remembered that the reviewer will not have the same familiarity with the project, and having no information other than what the analyst presents in the EA, may not be able to arrive at the same justification for alternative removal. The analyst needs to ensure sufficient information is presented in the project objective, background, status quo alternative, and each of the additional alternatives to enable the reviewer to assess and independently reach the conclusion to justify exclusion of each alternative.

b. Generally, there are only two ways an alternative can be determined to be non-viable.

(1) There is judicial guidance (public law, policy or regulation) which indicate constraints that must be adhered to. Example: Encroachment upon wetlands.

(2) There is a physical constraint. In this instance, an alternative is restricted due to a physical consideration. Example: A status quo facility is surrounded on four sides by other used facilities. This makes expanding the facility for renovation and new construction mix as non-viable.

c. During the discussion of alternatives, cost is not an issue. Alternatives cannot be classified as non-viable based on the assumption of prohibitive cost. Any statement which classifies an alternative as non-viable based on cost considerations will cause the analysis to be returned to the originator for correction (see chap 8).

d. Analysis at this stage is focused on screening alternatives for further study; differentiating those alternatives considered to be viable solutions from those that were considered but rejected in light of an external constraint. The discussion of each alternative should progress independently and should not compare the relative merits of one alternative over another. Each alternative discussion should be presented in paragraph format and include a statement summation of the alternative being analyzed, 2–3 sentences which present pertinent facts either supporting or rejecting the alternative as viable and a conclusive statement classifying the alternative as viable or non-viable. Statements of opinion should not be included into the discussion of any alternative. Any conclusive statement not supported by one or more independently verifiable facts will be dismissed as an opinion.

e. Any and all information necessary to convey a full understanding of how a project will fulfill the stated project objective, why the project is needed, and how enactment or denial of the project will enhance or impede the ability of the unit to perform its function should be included in the background section of the analysis.

f. Properly address the standard alternatives:

(1) Status quo (current operations). The status quo alternative is defined as the complement of facilities currently employed to satisfy the need as stated in the project objective. The status quo alternative is an “as is” alternative and does not include any modification to the current facilities; facilities are analyzed in their current condition. The status quo alternative is the baseline against which all other alternatives are measured. This alternative cannot be dismissed due to the assumption of prohibitive cost.

(a) The status quo is generally dismissed without subjecting the alternative to a full life-cycle cost analysis only in the event that the current facilities either 1) do not exist, 2) are of insufficient size to accommodate the mission need as stated

in the project objective, or 3) continued use of the status quo facilities constitute an unacceptable risk to occupant health, life or safety. In all other conditions, the status quo alternative must be subject to a full life-cycle cost analysis. NOTE: Only in a ROI EA is the status quo always included in the full EA.

(b) If the status quo condition is non-existent it is acceptable to state that this is a new requirement that no facilities or assets, either permanent, semi-permanent or temporary are being employed to satisfy this requirement.

(c) If the status quo condition exists, discussion of the status quo alternative should be the most lengthy of all alternative discussions. Discussion of the status quo alternative should contain a listing of all facility types or buildings being analyzed. Each facility or building should be identified by either building number or category code. For each facility or building the current square footage, the year of construction, classification (permanent, semi-permanent, or temporary), building use description and Installation Status Report (ISR) ratings should be included as well as a description of each facility. Avoid using subjective adjectives. Occupation of the building should be discussed; what unit is this facility designated for and how is this unit currently being accommodated? Is the unit being relocated from another DOD site or is it already on base? What is the current need of the unit for the proposed facility type? The status quo condition should describe any infrastructure issues and should present any ongoing or significant maintenance issues. Include any violations of health, safety or fire codes. Cite any citations received for infractions of these codes. Also included within this section is a summation of existing conditions that concisely supports the conclusion that the alternative is either viable or non-viable.

(d) If the alternative cannot be dismissed for one of the enumerated reasons, then it must be carried forward and subjected to a full life-cycle cost analysis in a ROI EA (In this pamphlet, para 3–3) or be determined to cancel the project request.

(2) Renovation of status quo. The renovation alternative is defined as the renovation of the status quo or the current facilities used to satisfy the project objective. This alternative does not pertain to renovation of any facility or asset not currently employed in the status quo alternative. This alternative does not include any additional square footage to any of the buildings contained in the status quo alternative.

(a) This alternative is generally dismissed without subjecting the alternative to a full life-cycle cost analysis only in the event that the current facilities either 1) do not exist, 2) are of insufficient size to provide for the space needed, or 3) the status quo facility is in such condition that renovation of the facility cannot be accomplished without completely demolishing the existing structure. If the alternative cannot be dismissed for one of the enumerated reasons, then it must be carried forward and subjected to a full life-cycle cost analysis (see para 3–3, step 3).

(b) Discussion of this alternative should draw heavily on the discussion within the status quo alternative. The discussion should highlight key facts of the status quo alternative, should contain verifiable facts which impact the ability of the status quo facility to undergo renovation, and should contain a conclusive statement which classifies the alternative as either viable or non-viable.

(3) Renovation and new construction mix of status quo. The renovation and new construction mix of status quo alternative is, like the renovation alternative, defined by the facilities in the status quo alternative but allows the construction of additional square footage in addition to the status quo facilities. Discussion of this alternative should also draw heavily on the discussion points within the status quo alternative. The discussion should highlight key facts of the status quo alternative and should contain a conclusive statement based on key facts supporting either conclusion of viability. If the alternative is dismissed due to insufficient space in which to expand; the discussion must discuss the area surrounding the status quo facilities and provide reasons why additional space cannot be constructed at a distance from existing facilities. If the alternative is dismissed due to reason of the laws, regulations or policies, cite, in sufficient detail that the source document can be located by a reviewer.

(4) New construction. The new construction alternative is defined as the complete new construction of all facilities stated in the project objective. This alternative does not include any use of facilities, which currently exist. This alternative cannot be dismissed due to the assumption of prohibitive cost.

(a) This alternative is generally dismissed without subjecting the alternative to a full life-cycle cost analysis only in the event that buildable space is not available (In this pamphlet, see para 2–3*a*(1)). Generally, new construction is the most prevalent solution advanced to meet any need; it is also the solution which receives the most scrutiny (In this pamphlet, see chap 8). If the alternative cannot be dismissed for one of the enumerated reasons, then it must be carried forward and subjected to a full life-cycle cost analysis.

(b) Discussion of this alternative should include a description of the intended site; reference the presence of a buildable site (topography, environmental considerations, and so forth), any adjacency or collocation requirements and the distances from those facilities and distance to infrastructure connection points. The discussion should identify alternative sites considered, if any, and the reasons why these sites were dismissed. Discussion should end with a conclusive statement supporting either conclusion of viability.

(5) Use of other facilities on base (as is; renovation and new construction mix; renovation). The use of other facilities on base focuses on the use of all available facilities on post. This alternative should analyze any available facilities on the

installation either as a solution to the entire need as specified in the project objective or in conjunction with status quo facilities, renovated status quo facilities, or newly constructed facilities.

(a) This alternative is generally dismissed based on the unavailability of suitable alternative facilities on the installation. Assessment of available facilities should focus on the physical attributes of subject facilities against the needs of facilities as stated in the project objective. Available facilities should not be dismissed because of category code considerations. If the alternative cannot be dismissed based on the inability to find suitable alternative facilities then it must be carried forward and subjected to a full life-cycle cost analysis.

(b) Confer with the installation Master Planner for the discussion of this alternative. The discussion should focus on the real property inventory Tabulation of Existing and Required Facilities (referenced as TAB) and specifically on the difference between required square footage and actual square footage on post. The discussion of this alternative should reference facilities, regardless of category code, which can reasonably be employed for the purpose as stated in the project objective. For any category code for which the installation has excess space, an explanation for rejecting its use in fulfilling the project requirement needs to be stated.

(6) Leasing. The lease alternative focuses on use of leased facilities located on post (for example, enhanced use lease) or off post (on the local market) to satisfy the project objective.

(a) The lease alternative is generally rejected based on the inability to locate the function or mission housed in a given facility in a leased facility. This may be due to the remote nature of the surrounding community and the unavailability of suitable facilities to lease or it may be due to the lack of leasable facilities on post. Rejection may also be based on leadership directives, which document or directive must be referenced, to locate a function or facility on post. Rejection may be due to the inability to move large pieces of equipment along city or county roads, the sensitive nature of what is being housed in the facility or the need to secure high value equipment or information. If the alternative cannot be dismissed for one of the enumerated reasons then it must be carried forward and subjected to a full life-cycle cost analysis.

(b) Discussion of this alternative should assess the ability to locate the subject function, mission or unit in a leased facility. If the function, mission or unit is precluded by leadership directive or other guidance document from being located off post, reference the title of the document, the date of its draft and who signed that document. If the function, mission or unit cannot be located off post due to logistical issues, provide a description of the logistical issue and the impact an off post location would have upon the function, mission or unit.

(7) Contracting services out (not OMB Circular A–76). This alternative is different from all other alternatives in that it analyzes the service to be provided in the requested facility and not the facility itself. In reference to the Government-owned, contractor-operated (GOCO) and the Government-owned, Government-operated (GOGO) alternatives discussed in paragraphs 3–2*f*(11) and (12), below this alternative can also be classified as contractor-owned, contractor-operated (COCO). Examples would include dining or catering services as an alternative to a building a dining facility (DFAC), gym memberships as an alternative to renovation of a physical fitness facility (PFF), contracted child care services as an alternative to a child development center (CDC), long term storage, non-tactical vehicle maintenance, and so forth, all services which can be obtained on the commercial market. As a result, this alternative is limited only to services for which there is an equivalent civilian alternative.

(a) Dismissal of this alternative is based on the ability to find a service provider on the local economy. If the alternative cannot be dismissed based on the inability to find a commercial service provider, then it must be carried forward and subjected to a full life-cycle cost analysis.

(b) Discussion of this alternative must assess the availability of an equivalent civilian alternative service provider within the local market. If the facility being analyzed does not have a commercial market equivalent (for example, tactical vehicle maintenance) this is all that needs to be stated. If the function, mission or unit cannot be located off post due to logistical issues, provide a description of the logistical issue and the impact an off-post location would have upon the function, mission or unit. Lastly, if the facility being analyzed has a commercial market equivalent and the function can reasonably be located off post, assess whether a viable service provider exists in the local market area.

(8) Use of other Department of Defense or Federal agency housing facilities. This alternative focuses on the use of facilities on other DOD installations or assets belonging to other federal agencies to satisfy the project objective.

(a) Dismissal of this alternative is generally based on 1) the unique nature of the facility, 2) the need to locate the facility in close proximity to some other asset or 3) command and control issues which would preclude location of the function, mission or unit at a point outside the installation fence line. If the alternative cannot be dismissed for one of the enumerated reasons, then it must be carried forward and subjected to a full life-cycle cost analysis.

(b) Discussion of this alternative should assess the need to collocate the facility being analyzed with other facilities. If there are no collocation issues, the alternative should asses the ability of the subject function, mission or unit to be located in an off post location. If location off post is viable, the alternative should record the presence of any comparable federally controlled facility within the local commuting area (within 1 hour commute from the installation).

(9) Basic allowance for housing. This alternative is specific to barracks projects and does not need to be addressed unless the project includes barracks spaces. This alternative assesses the ability of the Government to house Soldiers off post in a hotel or other commercial solution generally for a short period of time.

(a) This alternative is generally dismissed based on a documented requirement to locate Soldiers on post (for example, Soldiers undergoing basic training) or the lack of adequate accommodations on the local market (for example, housing large numbers of Soldiers off post at a remote base or installation location). If the alternative cannot be dismissed for one of the enumerated reasons then it must be carried forward and subjected to a full life-cycle cost analysis.

(b) Discussion of this alternative should assess the ability to house Soldiers in off post facilities. Any guidance document or directive which precludes the housing of specific Soldiers in off post facilities should be referenced. If there is no official preclusion then an assessment of the local market should be undertaken as to the number of rooms available, the distance from the installation to those facilities and the duration and frequency of use.

(10) Innovative alternatives. This alternative is intended to capture any solution which cannot easily be classified under the other alternatives specified above. Alternatives that include public-private partnerships with academia and industry is an example of an innovative alternative, which may include substantial non-monetary benefits that can impact the selection of an alternative other than the least cost alternative. EAs for innovative alternatives such as open campus concepts or innovation/technology hubs are encouraged to support Army innovation that stimulates research, development, tests and evaluation (RDT&E), increases collaboration and fosters creative staff execution between Army and industry to support agility in the acquisition process. It is vital that all realistic options be considered and documented for higher levels of review.

(11) Government-owned contractor-operated Defense Logistics Agency (DOL). This alternative focuses on the provision of Government assets to Department of Energy (DOE) a contractor to achieve a desired outcome. A well-known example of this partnership is the management of DOE Laboratories. During the Second World War, the Government asked the University of California to operate what is now Los Alamos National Laboratory. The Government provided the facilities, equipment, and established mission parameters and the university provided the scientists and engineers which produced the result. Following this model, many of the DOE laboratories are currently managed by Sandia Corporation, a subsidiary of Lock- heed Martin. In large part the use of this model has been limited to the production of munitions and the repair and reset of military vehicles under the purview of AMC.

(a) Use of this alternative is governed by the Federal Acquisition Regulation (FAR), Part 45, Subpart 45.3. The ability of the Government to provide facilities to a contractor is narrowly defined within this guidance document and is generally limited to industrial operations.

(b) In contrast to the GOGO alternative below, the contractor is responsible for operating and maintaining the Government owned asset.

(c) This alternative is generally dismissed based on the type of operation or mission being analyzed. If the purpose of the facility being analyzed does not meet the exclusions under which Government facilities can be provided to a contractor as set out in FAR 45.302 then this alternative is not viable. All that is required is to assert non-conformance with the FAR and that the alternative is non-viable. If the alternative cannot be dismissed based on inapplicability to the reference FAR sections, then it must be carried forward and subjected to a full life-cycle cost analysis.

(12) Government-owned Government-operated (Defense Logistics Agency). This alternative is largely the same as the GOCO alternative discussed in paragraph 3–2*f*(11) with one important exception. Within the GOCO alternative, the facilities and operations are managed out of Government owned facilities by a contractor. In contrast, the GOGO alternative has contractor personnel operating in a Government owned and operated facility.

(a) Like the GOCO alternative, GOGO is subject to the same sections and parts of the FAR.

(b) This alternative is generally dismissed based on the type of operation or mission being analyzed. If the purpose of the facility being analyzed does not meet the exclusions under which Government facilities can be provided to a contractor as set out in FAR 45.302 then this alternative is not viable. All that is required is to assert non-conformance with the FAR and that the alternative is non-viable.

(c) If the alternative cannot be dismissed based on inapplicability to the reference FAR sections, then it must be carried forward and subjected to a full life-cycle cost analysis.

g. Housing-alternatives to consider. The following alternatives are typically available as methods of housing military personnel and Families (other alternatives may be available in specific situations):

(1) Individuals rent housing on the economy. This alternative is required for each economic analysis where private rental housing is available, as demonstrated by a HMA. This alternative must include addition of sufficient housing referral services (HRS) resources to increase penetration of the market enough to cover all housing deficits.

(2) Individuals rent housing on the economy with the Army guaranteeing payment of the rent. This alternative must include addition of sufficient HRS resources to increase penetration of the market enough to cover all housing deficits.

(3) Army Family Housing Construction.

(4) Military Construction Army (for Army Housing).
(5) Government lease, or build, or build to lease.
(6) Renovate existing housing assets.
(7) Purchase existing housing assets.
(8) The analyst must study all feasible alternatives and present to the decision maker those that are most cost effective. This requires a great deal of skill and extensive interaction with the decision maker. It is important to consider all reasonable and viable alternatives or the value of the analysis may be seriously undermined. Good decisions are extremely difficult unless they are made with an understanding of all relevant options.
(9) As alternatives are developed, other objectives, selection criteria, characteristics of the problem, constraints, and assumptions must also be identified. It is essential that the analyst return to the section of the analysis that is affected by this new information. The new information must be included if the analysis is to be accurate, effective, and communicate with the greatest possible power. If this circular process does not occur, the analysis most likely is not being performed in sufficient detail to be credible.

3–3. Step 3: Classify economic analysis

There are two classification groups for defining the EAs. The first group is known as the kind of EAs (Nominal EA, Partial EA or Full EA, discussed below). The second group is known as the type of EA (Return on Investment and Mission Requirement, also discussed below). Based on the number of viable alternatives there are three possible kinds of economic analyses.

a. Nominal Economic Analysis. If the only viable alternative is one which has been specifically directed by legislation and that legislative mandate includes an exemption to the requirement for an EA then the analysis is classified as a nominal economic analysis. In other words, the legislative action must include not only the directive to engage in a project but a very specific mandate as to how the requirement is to be provided and a waiver as to the lack of need to assess any other alternative course of action. Even the inclusion of the EA waiver into the legislative action does not mitigate the need to document this finding into the project documentation. When an EA waiver is specified by Congress two pieces of documentation are required to be entered into the EA. A project objective must be stated (In this pamphlet, see paragraph 3–1. Second, a discussion of the project must be included into the EA. Discussion should include a statement of justification that cites in detail the particulars of the legislation (include the public law number), a statement which provides specific relevance to the project in question, and a conclusion that the project is exempted from the requirement for an economic analysis.

b. Partial Economic Analysis. If the result of the development of alternatives as discussed in paragraph 3–2, produces only a single viable alternative, then it is a partial EA and it is necessary to include the analysis of alternatives carried out in paragraph 3–2 and produce a results and recommendations statement in order to complete the analysis (see para 3–9). The recommendations statement need only be a brief statement of analysis results. The statement should include verification that all standard alternatives were considered and only a single alternative was found to be viable. The statement should overtly identify which alternative was found to be viable and classify that alternative as the preferred alternative.

c. Full Economic Analysis. If the result of the development of alternatives step produces more than one viable alternative, then the analysis is classified as a Full EA and it is necessary to complete all subsequent analysis, steps 4 through 9, as specified in this guidance document. Each viable alternative must be subjected to a full life-cycle cost analysis as defined in paragraph 3–6. Full life-cycle cost analyses are classified into one of two types of analyses: return on investment and mission requirement.

(1) *Mission requirement.* A mission requirement EA addresses a new requirement that is not adequately satisfied by the status quo or current condition. It is the appropriate analysis once a deficiency in status quo facilities has been identified or when a completely new requirement has been developed. See paragraph 3–2*a* through *c*, as examples of mission requirements. This also applies when the mission remains the same, but the equipment being maintained changes in size (such as fire trucks, tanks, and aircraft).

(a) The modified table of equipment (MTOE) for each firefighting company is increased to include chemical, biological, radiation, nuclear and explosive (CBRNE) equipment. If the current standard design for the department of emergency services (DES) does not include sufficient storage space to house this increase in equipment, a deficiency is identified.

(b) New mission requirements for facilities may be generated by any number of needs: the requirement to house 1,000 more trainees, a requirement to maintain an extra 100 tanks, or the need to provide a facility to meet increased demands of the mission. Mission requirements also result from the need to replace antiquated facilities or facilities which are no longer applicable to current mission requirements.

(c) In a mission requirement EA, the most economical option is selected from a group of options, all of which will perform the function or satisfy a mission. Expanding upon the example above, any number of alternative means can be used to satisfy the need for additional storage space for the new CBRNE equipment: an additional bay could be constructed

onto the existing DES, an autonomous storage building could be constructed on a land adjacent to the DES, or storage space in an existing warehouse could be allocated to the store this equipment.

(2) *Return on Investment.* The focus of a return on investment analysis is on reducing operating costs in the long run. Within the context of a return on investment analysis, the status quo facilities are sufficient from a fiscal standpoint although not ideal to ensure mission execution. A return on investment EA analyzes alternatives to the status quo or current condition to assess whether a better, more cost effective solution could be found that provides the same level of service for the existing requirement. This EA type answers the question whether the Government can achieve cost savings through a change in real property assets. An important note: in a return on investment analysis, the status quo alternative must always be viable and never have additional expenses added to that alternative. See items below (3–3*c*(2)(a) – (b)) as examples of Return on Investment.

(a) Assume that you are faced with the question on how to best conduct in processing of 125 newly enlisted Soldiers within a mandated 3–hour time frame. The current In-Processing Center is situated in a leased facility (350,000 square foot) in downtown New York City (Manhattan). This facility can process all 125 recruits within a 3–hour window. The Army has identified a warehouse on Ft. Hamilton, Brooklyn, New York, which is available to house this function. The warehouse is 200,000 square foot, and is capable of being repurposed (converted from one use (cat code) to another) to an In-Processing Center. This alternative would include renovation of the existing facility (removal of all materials to the exterior of the facility; existing roof was just replaced and will be used; existing heating, ventilation and air conditioning (HVAC) will be replaced) and a new 20,000 square foot addition. With new technologies, the Brooklyn facility will be reduced in size (compared to the Manhattan site of 350,000 square feet), and still meet the requirement of processing 125 enlistees in 3 hours. Could the in processing of new recruits, in the 3–hour time requirement, be accomplished at less cost in a smaller space than in the current facilities? The return on investment analysis answers this question.

(b) For a return on investment project to be viable, the life-cycle cost analysis must demonstrate a significant cost savings over the present method of meeting the requirement. Following the example above, if the warehouse can be converted to process 125 enlistees within the requisite 3–hour window utilizing less space, the Government will realize an efficiency savings. The costs to operate and maintain a 220,000 square foot building will be much less than the cost to operate and maintain a 330,000 square foot building. Movement to the smaller building should realize savings in maintenance costs, electricity costs, and possibly personnel costs. There is also the relative value of the building and land. A building and associated land in downtown New York is probably worth more than a building and land on a Government installation. The economic benefit of this efficiency factor increase is calculated to offset the cost of construction or in this case renovation of a new or refurbished facility.

d. Impact. Results of these the Mission requirement and Return on investment types of economic analyses have different impacts on the Army's cash flow. For a mission requirement analysis, the economically preferable alternative does not result in cost savings; it represents the least cost alternative relative to other possible solutions. Mission requirement EAs justify investments that start an expense stream. Return on investment EAs justify investments intended to reduce an existing cash flow.

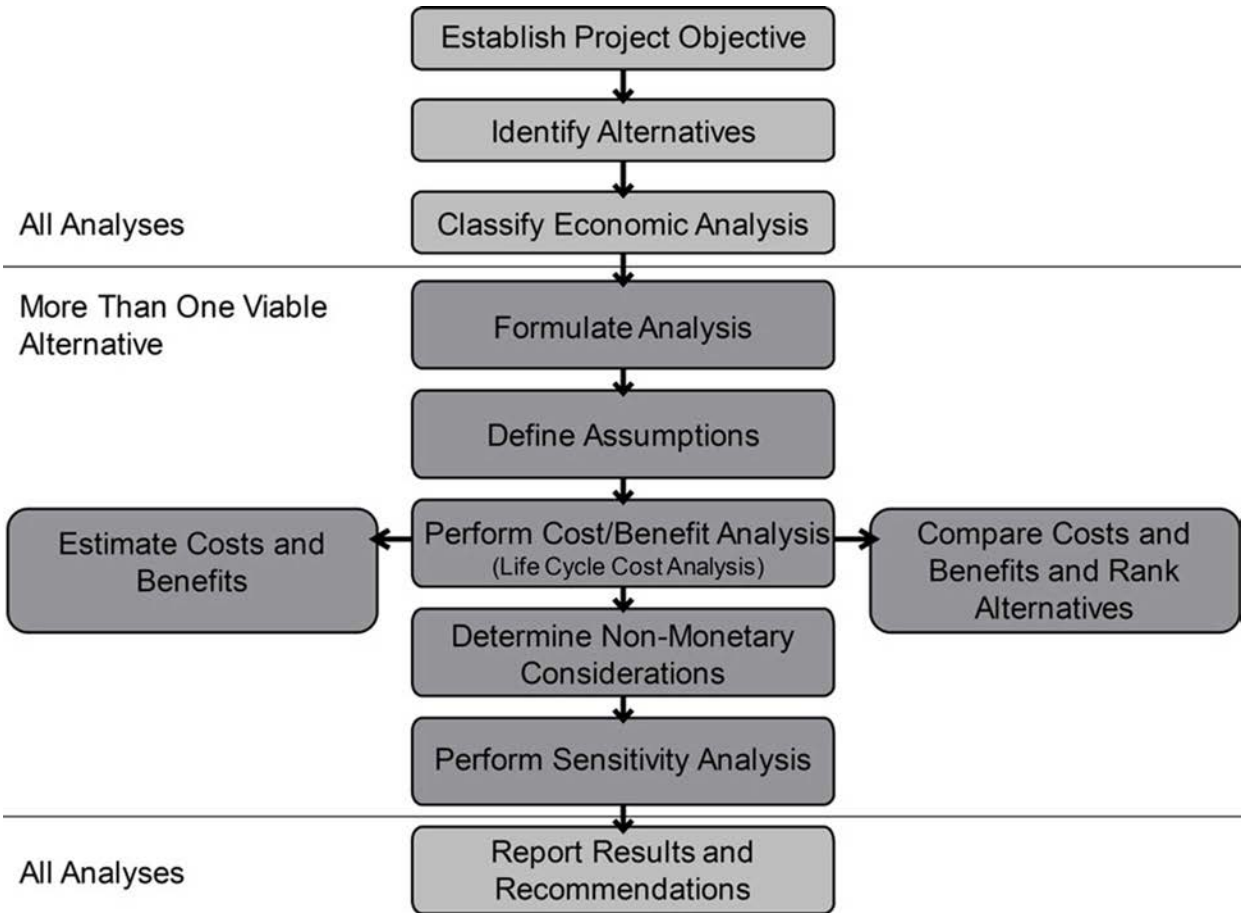


Figure 3–1. The economic analysis process

3–4. Step 4: Formulate analysis

The purpose of this step is to begin the process of collecting information necessary to performing a full life-cycle cost analysis on viable alternatives. Based on the results of paragraphs 3–2 and 3–3, which differentiate viable from non-viable alternatives, the analyst will need to formulate a data requirements list, which is inclusive of all information necessary to give a complete accounting of the costs and benefits of each viable alternative.

a. A full life-cycle cost analysis is a complex undertaking, which requires the analyst to account for all variables to 1) establish the total cost of an alternative, 2) inflate or deflate those costs accordingly, and 3) compare each alternative against all other viable alternatives.

b. The data requirements list should focus on the need for each cost category, probable sources of information for each required cost category, the relative difficulty of attaining this information, and the probable impact each variable will have on the outcome of the analysis. Paragraph 4–5 fully discusses inflation factors, chapter 5, discusses cost elements. Other required variables are discussed throughout other paragraphs of this regulation.

c. Based on the results of this step each variable identified as having an impact on the alternative will either be fully quantified (see para 3–6) or subject to a simplifying assumption (see para 3–5).

3–5. Step 5: Define assumptions

Based on the results of paragraph 3–4, the analyst should have an idea of those variables needed to give a complete accounting of the costs and benefits of each viable alternative, the relative difficulty of obtaining each piece of information and the relative impact that variable will have on the final outcome of the analysis. The analyst should be able to identify variables which may be subject to an assumption.

a. An assumption is a simplifying mechanism whereby a variable(s) having a small or minimal impact on the outcome of the analysis is assigned an educated or assumed value. Assumptions should only be made when the effort to calculate the value of a variable would require a significant amount of time with the results having little or no impact on the outcome of the analysis.

b. In most EAs, the analysts must make some assumptions. Common assumptions include the estimated useful life of an asset, the replacement time for a building component (such as a roof), and the need for future required repairs. An example is, in a given project the status quo alternative is made of five separate buildings which are geographically dispersed but which are similar in size, construction type, year built, usage and are all well maintained. The Department of Public Works (DPW) representative reports that only one of the five buildings has been fitted with an electricity meter. The effort necessary to calculate electrical usage in a given building which is not metered is relatively labor intensive; requiring the estimation of usage for each appliance or machine housed in each building. The resulting increase in accuracy from this method of estimation over the extrapolation of the results of the metered building would not materially increase the accuracy of the analysis. Rather than spend the time necessary to calculate the consumption of electricity in each of the five buildings it is permissible to utilize readings from the metered building and extrapolate to the other four buildings of the status quo.

c. Assumptions must be stated so that reviewers can assess their impact on the EA. Assumptions should never be used if factual data is available or can be obtained easily, as they can impact the validity of the analysis. The statement of an assumption should include the following pieces of information: 1) what the assumed value is, 2) why the value of the variable is being assumed and 3) how the assumed value was derived.

d. As discussed above, justification for an assumption should focus on the relative difficulty of obtaining more accurate information or data and the relative impact that information will have upon the outcome of the analysis. The justification behind the assumption may seem self-evident to analysts but may not be apparent to the subsequent reviewer. A simple justification statement will alleviate any ambiguity.

e. The discussion of the assumption should overtly state the value assumed.

f. Even with assumed values it is necessary for the guess to be an educated guess. The analyst must include information which suggests that the value of the variable was not random but was actually arrived at by some methodology or procedure. The discussion of the assumption should state the methodology or procedure utilized to arrive at the as value.

3–6. Step 6: Perform life-cycle cost analysis

This step is composed of three defined sub-tasks: 1) estimating costs and benefits, 2) documentation, and 3) compare costs and benefits.

a. Subtask 1: Estimate Costs and Benefits. Estimating the costs and benefits of each viable alternative is the most difficult and time-consuming part of an economic analysis. In previous steps, the analyst has identified the viable alternatives to be carried forward into a full life-cycle cost analysis, has developed a list of variables necessary to give a full and complete accounting of the costs and benefits of each viable alternative, and has made simplifying assumptions where appropriate. The analyst must now begin the task of collection and input of those variables into ECONPACK (see para 2–6).

(1) This task reviews cost and benefit variables that can be quantified in monetary units. Cost and benefit variables that cannot be quantified in monetary units are discussed in paragraph 3–7.

(a) Time variables: A full illustration of life-cycle cost analysis variables associated with time is presented in paragraph 4–1. Time Value of Money Reference sources for each variable are analyzed for each variable.

(b) Cost variables: Monetary cost issues are presented in chapter 5. Analysis of individual costs elements in chapter 5 includes a review of probable reference sources as well.

(c) Inflation variables: A detailed dialogue of inflation is presented in 4–5 Inflation with reference sources for each variable.

(d) Depreciation variables: A detailed discussion of depreciation issues is presented in paragraph 4–7 Depreciation with reference sources for each variable.

(e) Beneficial variables: A detailed presentation of beneficial variables is presented in chapter 6.

(2) The collection of data and other information is critical as the overall accuracy of the EA depends on the accuracy of the underlying estimates. In other words “Garbage In, Garbage Out”; meaningful conclusions can only be obtained from meaningful data.

b. Subtask 2: Sources and derivations. The analyst must be diligent in collecting and documenting all sources and references during data collection to collect and document all source and reference materials utilized in the estimation of each variable. If a calculation methodology was employed in the estimate of a variable point value, the algorithm utilized needs to be documented and included within the sources and derivations section of the economic analysis within ECONPACK.

c. Subtask 3: Compare life-cycle costs. This is the heart of the analysis. Comparisons give managers the information needed to make informed decisions. Once the costs and benefits for all options are found, one option can be compared with another. Comparison of life-cycle costs is also the easiest, because once the estimation of costs and benefits has been completed, the information will be systematically entered into ECONPACK which will automatically undertake the comparisons and ranking of alternatives. The ECONPACK software and its user's manual can be downloaded from https://pax.csd.disa.mil/ by clicking on the "Apps" icon (system access to PAX is required).

3–7. Step 7: Determine non-monetary considerations

Not all costs and benefits of a project can be expressed in monetary terms. Non-monetary costs or benefits are impacts for which a monetary measure or reasonable proxy is not readily available and universally accepted. Impacts on health and welfare, morale, safety, command and control, collaboration with industry and academia to ensure RDT&E innovation and acquisition agility for the Soldier and training effectiveness are important considerations to the total effectiveness of a proposed alternative.

a. A project alternative that reduces the time it takes for Soldiers to transit from barracks or Family housing to the medical facility would recognize benefits of reduced transportation costs. A reduction in transportation costs would be included in the life-cycle cost analysis, but would fail to capture beneficial impacts to Soldier and Family morale. Increases in morale have a direct effect on the ability of the military to enlist new Soldiers and retain personnel. These costs and benefits, if significant, may be used to justify an alternative other than the least cost alternative.

b. Alternatively, project alternatives that would otherwise achieve the project objective but induce a significant negative impact on the users of that facility may not represent the most efficient means of achieving the project objective. As an example, an analysis to provide an installation with a child development center (CDC) includes an alternative to renovate an existing but vacant building on the outskirts of main cantonment. Of particular concern, the intended building is located within two miles of the firing point for an artillery range. The life-cycle cost analysis shows that renovation of the existing building is more cost effective than new construction. However, the nonmonetary costs associated with ambient noise levels may offset the benefit of the least cost alternative.

c. Nonmonetary costs and benefits represent a quandary. On one hand, it is not possible, or even advisable, to attempt to quantify these costs or benefits. Doing so would consume considerable time and resources and any conclusions drawn would be subject to question. On the other hand, the impacts of these costs and benefits are readily apparent to the on-site experts. Continuing the above example of the CDC; there is little research available which would allow the analyst to translate the impact of ambient noise levels on the wellbeing of children into a monetary cost. Ascertaining this cost would require the analyst to engage various professionals (child psychologists, sound engineers, sleep pathologists, and so forth) at incredible expense. Those professionals on-site that work with small children on a daily basis will be able to provide a detailed assessment of the probable impacts of locating a CDC so near to a sudden and repetitive noise source.

d. Following the completion of paragraph 3–6, the analyst should assess and document non-monetary costs and benefits associated with all viable alternatives. It is recommended that non-monetary costs and benefits be captured through interviews with individual stakeholders or through a collective "brain storming" session with stakeholder groups.

e. These costs or benefits are to be documented in ECONPACK, in a section entitled, "Non-Monetary Considerations."

f. The analyst needs to provide a brief discussion of the non-monetary cost or benefit which includes sufficient information for an uniformed reviewer to understand: a) the nature of the cost or benefit, b) why the cost or benefit is being included in the analysis, c) reference the information contained in the discussion and d) what impact this benefit or cost has on the least cost alternative. Discussion or dialogue placed in this section should be used to further justify the least cost alternative or justify the selection of an alternative other than the least cost alternative.

g. Costs and benefits that can be readily converted to a monetary stream should not be included in non-monetary costs and benefits.

3–8. Step 8: Perform sensitivity analyses

A sensitivity analysis is a "what-if" exercise. In other words, a sensitivity analysis shows the risk and uncertainty of an output and examines its influence to overall output of a project. It tests whether the conclusion of an EA will change if some variable such as a cost, a benefit, or the discount rate changes. While the foregoing may sound complex, ECONPACK has an automated feature, which automates the performance of sensitivity analyses. The user selects cost variables subjected to a sensitivity analysis and performs the analysis in ECONPACK. There are some absolutes.

a. A sensitivity analysis is always performed on the discount rate.

(1) ECONPACK automatically produces the discount rate sensitivity analysis.

(2) The range of the discount rates presented are -1 through 100.

(3) The ECONPACK discount rate sensitivity report identifies, at which rate the ranking of an alternative will change (if at all).

(4) The analyst will report the results in the ECONPACK section, Results and Recommendation.

b. Cost sensitivity analyses are performed when–

(1) The results of the EA do not clearly favor any one alternative (either close net present, within $3 million or the same NPV).

(2) There is a great deal of uncertainty about a cost, benefit, or assumption in the EA.

(3) The summation of the life-cycle costs of one cost category represents a majority of total alternative cost (when the cost category represents more than 20 percent of the total discounted cost).

c. A change in a variable or assumption causes a change in the ranking of alternatives, the EA is said to be "sensitive" to that variable or assumption. By performing sensitivity analyses and including their results in the ECONPACK section for Results and Recommendations, the analyst ensures the decision maker that uncertainties in the EA have been tested and the results documented.

3–9. Step 9: Report results and recommendations

This step is composed of three defined sub-tasks: 1) rank alternatives, 2) recommendation, and 3) documentation in tab A of DD Form 1391. Appendix B explains the format for reporting results of the housing economic analyses, however the report template provides some useful information for MILCON economic analyses as well.

a. Subtask One–Rank Alternatives. Based on the results of the analysis performed in steps 6, 7, and 8 the analyst will be able to rank the viable alternative courses of action. The best alternative is the one that poses the least total cost, both quantitative and qualitative, to the Government over the period of time for which the requirement is to be met. The appropriate ranking method for a specific type of EA must be used. Specific techniques for ranking alternatives are given in chapter 4. For most EAs, the best alternative is the one which exhibits the lowest total NPV. In terms of the cost of an alternative and its effectiveness (benefits) in satisfying the project objective there are four potential outcomes of any economic analysis of two or more alternatives. A summary table of the four possible outcomes is depicted in table 3–1.

(1) Unequal cost and equal effectiveness. Majority of the MILCON EAs produce a result where the project objective is achieved with varying alternative (costs). If the economic analysis results in two or more alternatives having unequal cost but are equally effective in satisfying the project objective then the least cost alternative must be selected.

(2) Unequal cost and unequal effectiveness. Another common occurrence is where both the effectiveness of achieving the project objective and the cost varies between alternatives. In this circumstance the alternative which provides the largest ratio of effectiveness to cost must be selected.

(3) Equal cost and unequal effectiveness. If the economic analysis results in two or more alternatives having equal cost but differ in their ability to satisfy the project objective then the alternative having the highest level of effectiveness must be selected.

(4) Equal cost and equal effectiveness. Although rare, this occurs when the analysis returns two different alternatives which are equal in both cost and effectiveness. When encountering this circumstance, the analyst needs to verify that the alternatives are truly equal, that the effectiveness and costs of each alternative are fully articulated. If it is found that both the effectiveness of achieving the project objective and the costs of all viable alternatives are truly equal, then the preferred course of action is decided based on non-economic factors. Note: given the improbability of this outcome, an analysis which claims equality of alternatives will be subject to extreme scrutiny.

b. Subtask two–recommendation. Based on the ranking of the alternatives the analyst will recommend a course of action. This recommendation will be documented in the Results and Recommendations section of ECONPACK. It is important to state the recommendation because the cost comparison alone may not determine which alternative best meets the project objective. The recommendation will also include the results of the sensitivity analysis for both the discount rate and cost sensitivity (if performed).

c. Subtask three–documentation in tab A. Based on the outcome of the analysis one of the statements identified below must be inserted into tab A of the DD Form 1391, "Additional Paragraph".

(1) If a full economic analysis has been prepared and the recommended alternative is that which imposes the least cost to the Government, the following statement must be inserted into tab A: "An economic analysis has been prepared and utilized in evaluating this project. This project is the most cost effective method to satisfy the requirement." For clarification, a full economic analysis is defined as any analysis where more than one alternative is viable.

(2) If the analysis of alternatives, paragraph 3–2, produces only a single viable alternative the following statement must be included in tab A. "Alternative methods of meeting this requirement have been explored during project development. This project is the only viable option to meet the requirement."

(3) If a full economic analysis has been prepared and the recommended alternative is based on non-monetary considerations and not least cost, the following statement must be included in tab A: "An economic analysis has been prepared and utilized in evaluating this project. This project is the best method to satisfy the requirement."

(4) If the project is the result of a public law and the law explicitly states in the language that exemption from preparing an economic is granted the following statement must be included in tab A: "This project is mandated by Congress and is exempt from preparation of an economic analysis." Note: unless Congress has specifically stated within the language of a law that an economic analysis is not required you are required to complete the tab D Economic Analysis of the project DD Form 1391. Failure to complete this tab will result in rejection and return of the analysis.

Table 3-1
Beneficial outcome table

Costs	Effectiveness	Basis for recommendation
Unequal	Equal	Least Costs
Unequal	Unequal	Highest Effectiveness to cost ratio
Equal	Unequal	Most Effective
Equal	Equal	Non-Economic factors

Chapter 4
Present value, discounting, and metrics of economic analysis

Viable alternative methods of meeting the project objective are compared and ranked using the present values of a series of costs and benefits over time. If the results of paragraph 3–3, result in the presence of multiple viable alternatives, present value methods will be utilized to identify the least cost alternative within ECONPACK. However, there are other methods to rank alternatives; the various methods of comparing two or more alternatives are discussed in this chapter.

4–1. Time value of money

The value of $1,000 today is not the same as $1,000, 5 years from now. The concept of time value of money is fundamental to the conduct of an EA and must be understood before other aspects of the analysis can be discussed. Money is both a perishable and a productive commodity. Everyone has witnessed the perishable nature of money or inflation; the tendency for the prices of goods and services to rise over time. Effectively, inflation erodes the value of a dollar so that what used to cost a dollar, now costs $1.25. Everyone also knows the productive nature of money or interest; the idea that you can loan a sum of money for a certain period of time and receive more money back than the amount originally loaned. Effectively, interest is compensation for the use of that money over the period of the loan. The interest rate charged is equal to the annual inflation rate and the rate of compensation for the use of that money. Admittedly, there are other factors which impact the time value of money but for the purposes of this discussion we will focus on inflation and interest on a loan. Loan interest will be discussed in this section whereas inflation will be discussed in paragraph 4–5. Inflation with a short discussion of deflation in paragraph 4–6.

a. Interest: Interest is expressed as a percent or decimal representing the fractional amount of a loan the borrower must pay the lender within a specified interval of time.

b. Simple interest: Suppose an amount of money, P, is borrowed today at an annual interest rate, i. The amount of money borrowed, P, is called the principal. Assume that the money is to be repaid at the end of 1 year. At that time, the borrower will have to pay the lender not only the principal, P, but an additional amount, P x i. This surcharge, P(i), is the price (interest) the borrower must pay for the use of the money for the year that the loan is outstanding. So, the total future amount, F1, paid to the lender is (see fig 4–1):

$$F1 = P + P\,i = P\,(1 + i)$$

Figure 4–1. Simple interest

c. Compound Interest : Now suppose the above loan is to be repaid at the end of 2 years instead of 1 year. The amount which would have been repaid at the end of year 1 is P (l + i), as shown in figure 4–2. This becomes the principal at the

beginning of the second year; that is, the interest has been compounded at the end of year 1. The amount repaid at the end of year 2 is:

$$F2 = F1(1 + i)$$
$$F2 = P(1 + i)(1 + i)$$
$$F2 = P(1 + i)^2$$
or
$$Fn = P(1 + i)^n$$

Figure 4–2. Compound interest

d. Figure 4–2 shows the equation to compute the total amount to be repaid to a lender, Fn, at the end of n years for an amount, P, loaned today at an annual rate of interest, "i".

e. Figure 4–3 shows the amount of interest paid on a savings account as an example of compound interest.

Problem: A savings account is opened at a bank with an initial deposit of $10,000. If the bank pays interest on savings at the rate of 10 percent per year, what will be the bank balance after three years? (Assume no deposits or withdrawals in the 3 years.)

Solution: This is the same as a loan to you by the bank.
Here, P = $10,000, i = 0.10, n = 3, and by Equation 3-2:

$$F_3 = \$10{,}000(1+.10)(1+.10)(1+.10)$$
$$F_3 = \$10{,}000(1+.10)^3$$
$$F_3 = \$10{,}000(1.331)$$
$$F_3 = \$13{,}310$$

Figure 4–3. Example of computing compound interest

4–2. Present and Future Value

Present value and future value calculations are integral to economic analysis. Present value allows the analyst to bring future costs occurring at various points in a projects life cycle back to a common point in time. Future value allows the analyst to escalate costs occurring in the present to a future point in time.

a. Future Value. Another way of viewing this is from the point of view of the lender; that the future value to the lender of P dollars loaned today is P (1 + i)n dollars, n years from today. The borrower, in order to secure P dollars today, must be willing to repay P (l + i) n dollars n years from today. The amount borrowed is equal to the amount repaid minus the time value of money. Using figure 4–2, any principal amount can be converted to a future value.

b. Present Value. The reverse is also true. Rearranging the equation, any future amount can be converted to its present value. If the principal, P, in figure 4–4 is viewed as the present value (PV) of a future payment, Fn, the relationship can be expressed as:

$$PV = Fn\left(1 \Big/ (1+i)^{n}\right)$$

Figure 4–4. Present value

c. Value. In figure 4–4, Fn represents the dollar amount value n years in the future of an investment at an interest rate, *i.* PV represents a cash equivalent in today's dollars (that is, a present value or present worth). The quantity 1/(1 + i)n, which is a number less than unity, reduces the future cash amount, Fn, to its equivalent PV, and is called a discount factor. Note. In the present value calculation (see fig 4–4), is no longer referred to as the interest rate but as the discount rate. Discount rates are specified in OMB Circular A–94, Appendix C. This appendix is revised yearly when interest rates and inflation assumptions are changed in the U.S. budget. Figures 4–5 and 4–6 show examples of computing the present value rather than the future value.

Problem: An evaluation of a research and development facility reveals that the HVAC system will need to be replaced every eighteen years. Assume that the cost to replace the HVAC system at a future time has been calculated to be $40,000. If the interest rate is assumed to equal 8 percent, how much must the Army set aside today to fund replacement of the system in 18 years?

Solution: Here, Fn = $40,000, i = 0.08, n = 18, and by Equation 3-3:

$$PV = Fn\,(1/(1+i)^{n})$$

$$PV = \$40,000\,(1/(1.08)^{18})$$

$$PV = \$40,000\,(0.250249)$$

$$PV = \$10,009.96$$

Conclusion: The Army would need to put aside $10,009.96 in today's dollars and invest that money in an investment account that earns 8% to have sufficient funding 18 years from today to fund HVAC replacement.

Figure 4–5. Example of computing present value for investment purposes

Problem: An installation needs to re-roof a large building. Roof Material A has a life span of 15 years and will cost $2M to replace at that time. Roof Material B will last 22 years with a replacement cost of $2.8M. An interest rate of 10 percent is used to compare the two alternative materials.
What is the least cost with respect to replacement cost?

Solution:
Roof Material A:

$$PV = \$2,000,000\,(1/(1.10)^{15}) = \$2,000,000\,(.239392) = \$478,784.10$$

Roof Material B:

$$PV = \$2,800,000\,(1/(1.10)^{22}) = \$2,800,000\,(.122846) = \$343,968.73$$

Conclusion: Based on the present value calculation; the Army would need to put aside less money in the current year to enact Roof Material solution B rather than Roof Material solution A. Roof Material B is, therefore, the preferred course of action.

Figure 4–6. Example of computing present value for a least-cost comparison

d. Investment. The Army is no different from a private investor in that it seeks the highest rate of return on its investments. Thus, in Army economic analyses, future costs and benefits are brought to a common point in time so that valid comparisons can be made. This methodology supports the decision maker by providing information on the various alternatives and identifying that alternative course of action which is the most economically efficient.

e. Impact. It is possible that there are numerous alternative courses of action to provide for a given need.

f. Example. A unit responsible for training diesel mechanics may require additional classroom space to accommodate an increased student load. Possible solutions may include options to increase utilization of existing classrooms, construct new classrooms, renovate space in buildings adjacent to current spaces or convert underutilized storage spaces into classrooms. Each course of action will require the expenditure of funds occurring at different points in time in order to provide and maintain mission readiness of the unit. To make meaningful comparisons, costs and benefits occurring at different points in time must be converted into equivalent costs and benefits occurring at a single point in time. This methodology allows the decision makers to compare alternative courses of action which may vary substantially from each other in order to make a decision on which is best for the unit and the Army. Figure 4–7 shows the differences between various alternative methods of providing for a given need.

Projects A, B, and C each require equal investments, but the occurrence of costs varies by years as shown below

Year	A	B	C
1	$7,500	$0	$5,000
2	$7,500	$0	$12,000
3	$7,500	$0	$16,000
4	$7,500	$0	$3,000
5	$7,500	$37,500	$1,000
Total (Non -discounted) Cost	$37,500	$37,500	$37,500

Alternative A:

Year	Cost ($)	10% Discount Factor	Present Value ($)
1	$7,500	0.909	$6,818
2	$7,500	0.826	$6,198
3	$7,500	0.751	$5,635
4	$7,500	0.683	$5,123
5	$7,500	0.621	$4,657
Total (Discounted) Cost			$28,431

Alternative B:

Year	Cost ($)	10% Discount Factor	Present Value ($)
1	$0	0.909	$0
2	$0	0.826	$0
3	$0	0.751	$0
4	$0	0.683	$0
5	$37,500	0.621	$23,285
Total (Discounted) Cost			$23,285

Alternative C:

Year	Cost ($)	10% Discount Factor	Present Value ($)
1	$5,000	0.909	$4,545
2	$12,000	0.826	$9,917
3	$16,000	0.751	$12,021
4	$3,000	0.683	$2,049
5	$1,500	0.621	$931
Total (Discounted) Cost			$29,464

Conclusion: Disregarding the time value of money, the alternatives are equal in cost. But, incorporating the time value of money and using a 10 percent discount rate shows that alternative B is preferable to either of the others.

Figure 4–7. Example showing impact of the time value of money

4–3. Methods of economic analysis

This section describes five EA metrics used to compare alternatives. NPV is the dominant metric, as it must be calculated regardless of the peculiarities of the project, while the other metrics may be calculated at the discretion of the analyst. Each metric description includes examples of how and when to use it. One or a combination of these methods can be used to evaluate alternatives in any EA performed to analyze MILCON projects.

a. Developing cash-flow diagrams. One of the first steps in organizing cost/benefit data in an EA is to list all costs, benefits, and their timing for each alternative. Often a cash-flow diagram is used to depict this information. A cash-flow diagram displays the timing and magnitudes of all costs associated with a given alternative in graphic form. A cash-flow diagram is typically drawn for each alternative in an analysis. See figure 4–8 for a cash flow diagram example.

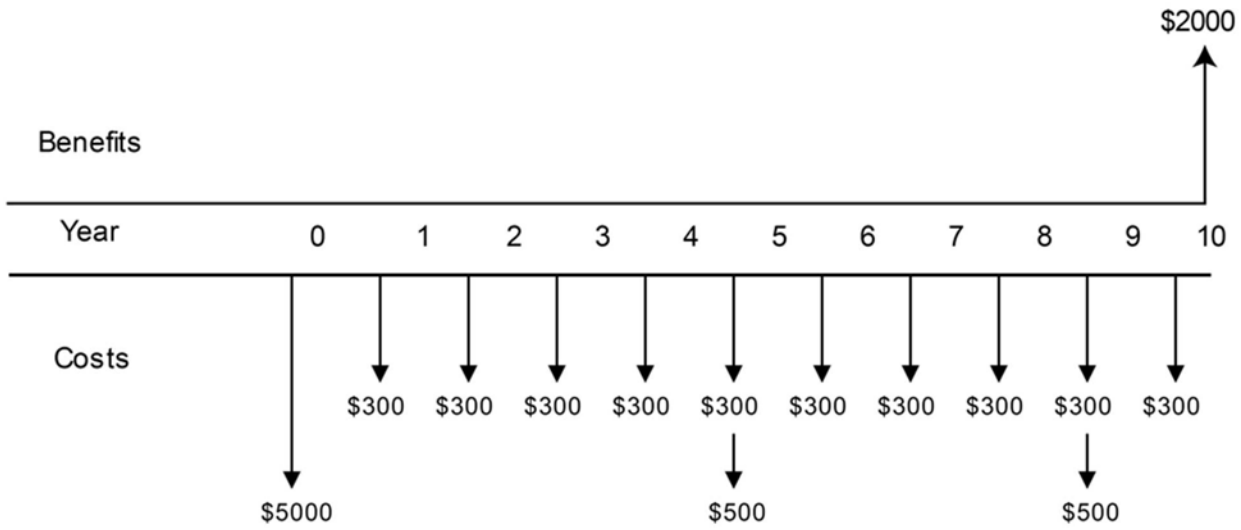


Figure 4–8. Example cash-flow diagram

b. Net present value. This method is the "standard" way to compare alternatives in the MILCON process. It is the method cited as the preferred method of analysis by most DOD and Army regulations. NPV is calculated for each alternative. The alternatives are ranked and the one with the lowest NPV is identified as the least cost alternative. The NPV is calculated for an alternative by discounting the values of a series of costs or benefits or their net differences which occur at various points within the life of the alternative and then summing those values to arrive at a total or net value.

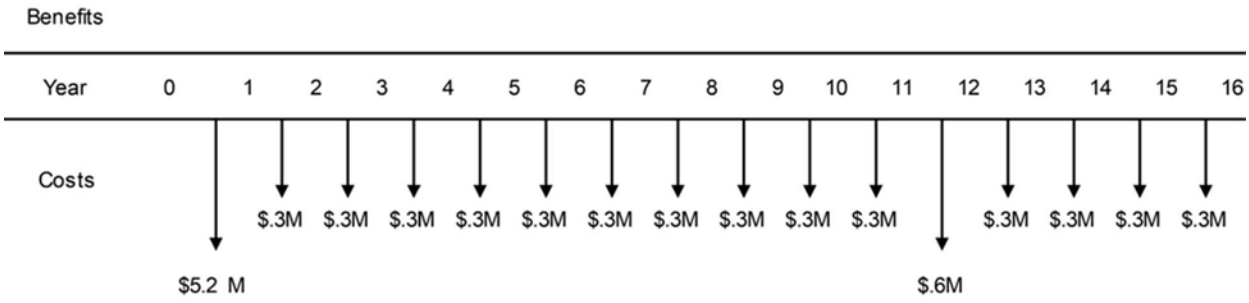
(1) Figure 4–8 presents the calculations necessary to discount all costs and the residual value to the base year (2008) of the analysis. Note that, in the equations below, cumulative factors are used for a cost that occurs every year and single amount factors for a one-time cost. Figure 4–9 contains cash diagrams for two alternative means of providing for classroom space. The first alternative is a renovation alternative composed of an initial cost, annual maintenance costs, and a re-roofing cost in year eleven. The second alternative is a new construction alternative composed of an initial construction cost and an annual maintenance cost. It also has a large residual value. Both the renovation alternative and the new construction alternative would require 1 year to complete and would have a period of analysis of 15 years. The analysis base year is 2008 and the discount rate is assumed to be 10 percent.

(2) The results of this analysis yield NPVs for each alternative: new construction equals $7,212,671 and renovation equals $7,233,894.

(3) The difference of $21,223 shows that new construction is the most economical alternative. Because the NPVs are very close, a cost sensitivity analysis would be performed and non-quantifiable factors considered before a recommendation could be made. This example shows that all life-cycle costs need to be considered; initial costs alone do not provide enough information to support a decision.

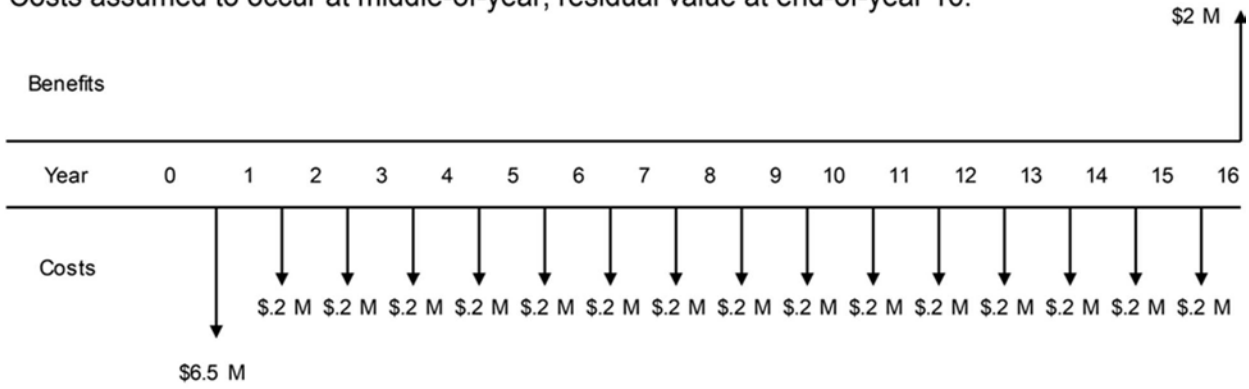
Renovation:

Initial renovation cost of $5.2M, annual operation and maintenance (O&M) costs of $0.3M, and a re-roofing cost of $0.3M in year 11. All costs assumed to occur at middle-of-year. This alternative has no residual value.



New construction:

Construction cost of $6.5M, annual O&M costs of $0.2M, and a residual value of $2M Costs assumed to occur at middle-of-year; residual value at end-of-year 16.



Discount rate is 10 percent. All costs are discounted by middle of year except the residual value which is end-of-year.

$$NPV_{REN} = \$5.2M\ (1/1.1^{0.5}) + \$0.3M\ (1/1.1^{1.5}) + \ldots + \$0.6M\ (1/1.1^{11.5}) + \ldots + \$0.3M\ (1/1.1^{15.5})$$
$$= \$5.2M\ (0.953) + \$0.3M\ (0.867) + \ldots + \$0.6M\ (0.334) + \ldots + \$0.3M\ (0.228)$$
$$= \$7{,}233{,}894$$

$$NPV_{NEW} = \$6.5M\ (1/1.1^{0.5}) + \$0.2M\ (1/1.1^{1.5}) + \ldots + \$0.2M\ (1/1.1^{15.5}) - \$2M\ (1/1.1^{16})$$
$$= \$6.5M\ (0.953) + \$0.2M\ (0.867) + \ldots + \$0.2M\ (0.228) - \$2M\ (0.218)$$
$$= \$7{,}212{,}671$$

Using NPVs, the new construction alternative is the more economical solution as its NPV is $21,223 (0.3 percent) less than that of the renovation alternative.

Figure 4–9. Example using net present value to rank alternatives

c. Savings-to-investment ratio. As described in paragraph 3–3. Step 3 full EAs are classified by one of two types: a return on investment or a mission requirement.

(1) A mission requirements EA supports the calculation of a savings/investment ratio (SIR) as there is no status quo against which various alternatives can be compared. The SIR answers the basic question: "Are the recurring savings of the alternative relative to the status quo large enough to justify the investment costs needed to implement the alternative?"

(2) In a return on investment EA, a proven solution is measured against alternatives which may prove to be more efficient, resulting in some measure of cost savings. Efficiency of the alternative solution is measured not only by way of standard NPV calculations, but is also measured and evaluated by the SIR calculations. The SIR compares the efficiency potential of each alternative against the status quo or current method used to meet the requirement. SIR means exactly what it states: the ratio of savings resulting from an alternative solution (to the present method) to the investment required for implementing the new alternative.

(3) The nominal undiscounted SIR is calculated as shown in figure 4–10.

$$SIR_U = \frac{\sum Savings}{\sum Investment}$$

Figure 4–10. Savings-to-investment ratio

(4) Thus, for an investment to be economically feasible, the SIR must be greater than 1.0. If there are several alternatives, their SIRs can be compared (ranked). However, the analyst must assess or factor into the decision other implications of the analysis such as the relative level of investment required or savings achieved. Normally, the alternative with the higher SIR would be preferred, but when comparing the sum total of the savings attributable to each alternative over the life of the project, if the total dollar savings of the alternative with the lower SIR is very large relative to the total dollar savings attributable to the alternative having a higher SIR, the alternative with the smaller SIR may be the preferred alternative.

(5) Example One: Assume that in our analysis we defined two alternatives for comparison against the status quo. The first alternative titled "Renovation Alternative" might have an SIR of 5.0 while another alternative titled "New Construction Alternative" has an SIR of only 2.0. The renovation alternative comprises a short term fix to a known problem whereas the new construction alternative comprises a more permanent solution. The cost to implement the renovation alternative is only $5,000 but will save the Government $25,000 over the life of the project. The cost to implement the new construction alternative is $2,000,000 but will save the Government $4,000,000 over the life of the project.

(6) The SIR is used only to compare the ratio of investment costs to savings to determine if the investment costs can be recovered through savings. In the example above, the SIR of the short term fix is much higher and provides the Government with a 500 percent return on funds invested. However, this course of action represents a short term solution and may require the Government to revisit the problem within a shorter period of time than a new construction alternative. This is a risk to the Government and should be factored into the economic analysis. The point is that the solution with the highest SIR may not be in the best interests of the Government.

(7) It is possible for the results of a NPV calculation to contradict the results of an undiscounted SIR calculation. When computing a single SIR, that is an SIR for a single course of action, it is not a requirement to discount costs and benefits. Costs and benefits for a single course of action may be represented as the difference between annual costs for the alternative over the existing condition. When computing a SIR to compare two or more alternatives to the existing condition it is necessary to discount the costs and benefits of all alternatives. If the costs and benefits for an SIR which evaluates multiple alternatives are not discounted, the results may conflict with the results of the NPV calculation.

(8) Example Two: Assume that an engineer on your staff has proposed the installation of light emitting diode (LED) street lights throughout the installation. The engineer states that installation of these new lights will require 2 years to implement and will require an investment of $30,000 each year. Through this investment, the installation will realize $180,000 in energy savings before the bulbs need replacement at the end of 8 years. The undiscounted SIR calculation is perfectly suited to this purpose and shows that this project will result in a 300 percent return on investment; SIR = 3.0.

(9) The equation to arrive at the discounted SIR is given in figure 4–11.

$$SIR_D = \frac{\sum PV_S}{\sum PV_I}$$

Figure 4–11. Discounted savings-to-investment ratio

(a) Where the SIRD (Savings to investment, discounted) is the discounted SIR and is equal to the summation of the present value of all savings, "PVs" divided by the present value of all investments, "PVI".

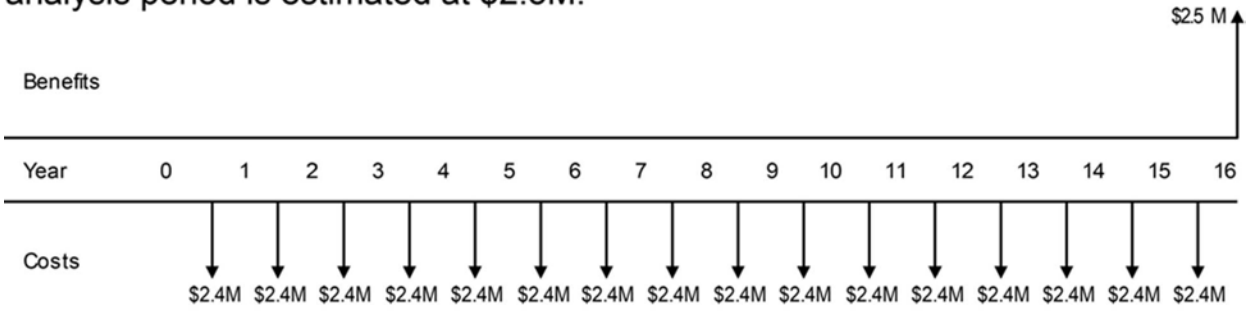
(b) If an SIR is calculated for each time period, it is possible to observe the fluctuations in the SIR over the life of the project. ECONPACK supports this kind of analysis by graphing a year-to-year SIR curve.

(10) Example Three: A comparison of discounted and undiscounted SIRs is presented in table 4–1. Assume that the same engineer on your staff returns with a second alternative. In addition to the LED solution provided above, she also details a compact fluorescent light (CFL) solution. The CFL solution has investment costs of $30,000, can be implemented in a single year, will last 9 years but will provide only $91,000 in savings before requiring replacement. The annual savings over 9 years is equal to $10,111.11 ($91,000/9 years). As stated above, the LED solution will have an initial cost of $30,000 for 2 years followed by 8 years of annual cost savings equal to $22,500 ($180,000/8 years). The CFL alternative results in a non-discounted SIR of 3.03 whereas the non-discounted SIR of the LED alternative equals 3.0. This example shows a total savings over the life of the project for the LED alternative equals $44,943.42 with the CFL alternative having savings equal to $24,469.43. The NPV calculation contradicts the undiscounted SIR calculation and favors the LED alternative. Use of the discounted SIR alleviates this problem. The discounted SIR for the LED alternative equals 2.34 and the discounted SIR for the CFL alternative equaling 1.94. The discounted SIR and the NPV both recognize the LED solution as the preferable solution.

(11) A more detailed presentation of a discounted SIR with NPV calculations is shown below in figure 4–12.

A Military Intelligence (MI) company is currently housed in three separate buildings spread over two cantonment areas. The first of these buildings is more than 40 years old and has a failing HVAC system. The second building is a leased relocatable structure. The third building is less than 5 years old and is in good repair.

Status Quo Alternative:
The assignment of real property in support of this unit causes the unit to incur the following costs: annual building O&M: $.789M, Utility: $.546M, Transportation $.446M, Security $.249M and $.370M for estimated efficiency losses or total annual costs of $2.4M. The residual value of the third building at the end of the analysis period is estimated at $2.5M.



New construction alternative:
Construction of a consolidated purpose building facility would cost $12.7M to construct with an annual incurred costs of $0.92M (O&M: $.26M, Utility: $.44M, Transportation $.10M, Security $.12M and $.0M for estimated efficiency losses) and a residual value at the end of the analysis period of $9.25M

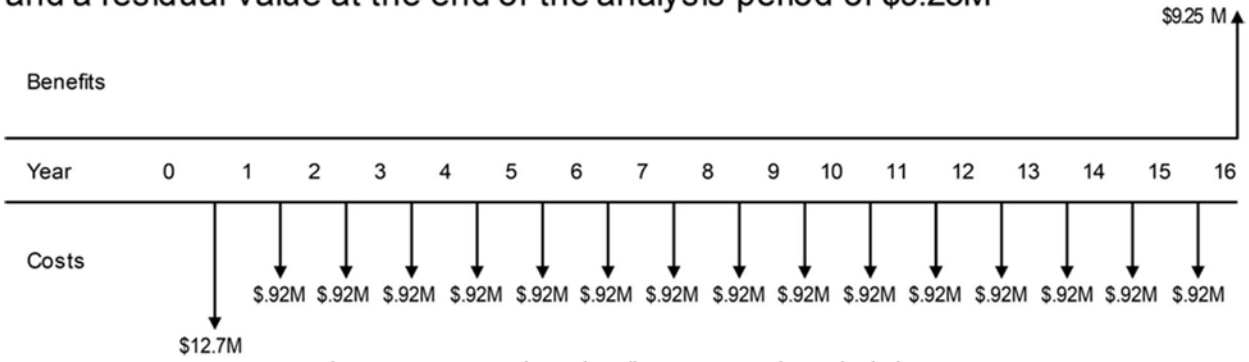


Figure 4–12. Example savings/investment ration calculation

(12) In order to calculate the annual net savings of engaging in the new construction alternative, the total estimated annual cost of the new construction alternative is offset against the total estimated annual costs of the status quo alternative. The annual net savings is equal to $1.48M per annum ($2.4M-$0.92M = $1.48M). The annual net savings is then discounted using the appropriate discounting factor for each year of the analysis. Calculation of the total investment cost is the sum total of the present value of the construction ($12.7M * 0.953 = $12.11M) cost minus the present value of the residual value of the newly constructed building ($9.25M * .218 = $2.013M). In this example we do not compensate for

the residual value of the status quo building because we do not know the disposition of the building. The building may have been demolished or it may have been refurbished for another use.

d. Payback period. An easily understood method of comparing alternative investments or for evaluating a single investment is to calculate the "payback" period. The payback period is the length of time between the project's start year and the point in time when the cost or investment amount of the project exactly equals the savings attributable to the project. Stated differently, it is the number of months or years that need to pass before the accumulated savings of the project offset the costs of implementation.

(1) Example One: If the cost to consolidate a Military Intelligence Company from three buildings into a single building costs $15,000 to implement but yields an annual savings of $2,500 in vehicle maintenance and fuel, the payback period would be 6 years.

(2) The payback period is often used in conjunction with the SIR. If the SIR is greater than 1.0, indicating the project pays for itself, the question then becomes: "How long does it take to recoup the investment costs?" All other things being equal (ceteris paribus) the alternative with the shortest payback period would be the preferred alternative. This preference for a shorter payback period is based on risk assessment. The range of potential risks that could impact a project's profitability increases and the ability of the analyst to account for risk decreases as one goes further out in time. The range of risks is narrower in the first and second year following implementation than it is in the 11th and 12th year. An alternative with a short payback period increases the probability of achieving project objectives and a net beneficial impact. The equation for the undiscounted payback period is given in figure 4–12 and the equation for the discounted payback period (DPP) is given in figure 4–13.

The analysis is performed in 2015 (base year), start year is 2015, and BOD is 2016. The requirement is for 15 years, so the period of analysis is 16 years. A 10 percent discount rate is used with a middle-of-year discounting convention for all costs except the residual, which uses end-of-year. It is assumed that the 5 year old building of the status quo alternative will be repurposed should the new construction alternative be funded.

NPV (Savings) = ($2.4*M* - $0.92*M*) (0.867)+ …+ ($2.4*M* - $0.92*M*) (0.228) = $10.733*M*
NPV (Investment) = $12*M* (0.953) - ($9.25*M*) (0.218) = $10.096*M*

$$\text{SIR} = \frac{\$10.733\text{M}}{\$10.096\text{M}} = 1.06$$

Figure 4–13. Undiscounted payback period

(3) Like the SIR calculation, it is possible to compute both a discounted and an undiscounted payback period. Like the SIR calculation an undiscounted payback period calculation (see fig 4–13) should only be used when discussing the merits of a single project. A DPP calculation (see fig 4–14) should always be utilized when comparing one alternative against another.

$$DPP = \frac{\sum PV_I}{\sum PV_{SN}}$$

Where:
DPP = discounted Payback Period
PV_{SN} = Present Value of Periodic Benefits (annual, monthly or weekly)

Figure 4–14. Discounted payback period

(4) The DPP is computed by taking the discounted value of the initial investment cost of the project and offsetting that cost against the discounted value of the annual savings. The value of the discounted savings is then summed into a running total and offset against the discounted value of the investment. When the value of the summed savings is greater than the value of the discounted investment cost the project has reached parity or payback.

(5) The DPP should not be used as the sole means of alternative selection. The DPP does not compare the relative size of the alternatives, neither their costs nor savings, and will always favor a short term solution. Short term alternatives may represent less than ideal solutions and may not achieve all of the objectives of the project. Realistically, the DPP, like SIR, should be interpreted with the NPV as an aid in selecting the best alternative. The duration of project life has no effect on the payback period. For example, a payback period of 10 years has the same meaning whether the economic life is 15 or 25 years. Thus, the payback period can be used to help screen and, in some cases, rank alternatives. Options with quick payback are generally preferred. An example of a DPP calculation is presented below in figure 4–16.

e. Return on investment. Return on investment (ROI) is sometimes broadly used to refer to a number of economic indicators even as simple as the present value of the benefits received from an investment. However, when considering ROI, one needs to consider the amount invested to achieve the returns. Obviously, the more one invests, the more benefits one would expect to receive as a result of those investments.

(1) In determining whether we have a return on our investment, we need to consider whether or not the investment pays for itself. An SIR equal to 1.0 indicates that the present value of the savings equals the present value of the investment. Where the savings and investment costs are equal is defined as the breakeven point. An SIR of 1.0 indicates that the investment is fully recouped over the period of analysis. In this case, there is no return on the investment at all because all that happens over the period of analysis is that you get your money back. Since discounting takes into account the time value of money, the net effect of all your efforts is as if you did not invest any money at all.

(2) If on the other hand, the SIR is 1.5, then you have recouped your investment and increased it by half or 50 percent. So, there is a 50 percent ROI. This leads us to figure 4–15.

$$ROI = (SIR-1) \times 100\%$$

Figure 4–15. Return on investment

$$BCR = \frac{NPV\ Benefits}{NPV\ Costs}$$

Figure 4–16 Example of discounted payback period

f. Benefit/cost ratio. A complete EA will identify all costs and benefits of each alternative. While most, if not all, costs of a project can be quantified into monetary units, some benefit categories do not lend themselves to quantification. "Benefits" is an aggregate category which can include such things as savings, output, products, yields, and other monetary units, but can also include non-monetary benefits such as improvements to health, life and safety, reductions in pollution, or increases in morale. Quantifiable benefits, if any, are included in the benefit/cost ratio (BCR) calculation, while non-monetary benefits or qualitative benefits should be included in a subsequent section of the analysis (within ECONPACK there is a section titled non-monetary benefits). Development of non-monetary benefits is discussed in chapter 6. The benefits of each alternative must be expressed so that the decision maker can make valid comparisons. This step is done using the BCR method. In general, the BCR is expressed as shown in figure 4–17. The resulting BCR provides a measure of total benefits relative to total costs. The larger the BCR: the more dollars of benefits there are compared to each dollar of cost, the more effective the alternative.

To find the DPP, the total NPV of investment is compared to the cumulative NPV of savings for each year. The point at which they are equal is the DPP.

Given the findings of the SIR calculation in Figure 4-8 above the following is the calculation for the DPP.

Investment Cost	$ 12,700,000.00
Annual Savings	$ 1,480,000.00

Year	Discount Rate	Cumulative NPV Investment Costs	Cumulative NPV Savings	Difference
0	0.953462589	$ 12,108,974.88		$ (12,108,974.88)
1	0.866784172	$ 12,108,974.88	$ 1,282,840.57	$ (10,826,134.31)
2	0.787985611	$ 12,108,974.88	$ 2,449,059.28	$ (9,659,915.60)
3	0.716350555	$ 12,108,974.88	$ 3,509,258.10	$ (8,599,716.78)
4	0.651227778	$ 12,108,974.88	$ 4,473,075.21	$ (7,635,899.67)
5	0.592025252	$ 12,108,974.88	$ 5,349,272.59	$ (6,759,702.30)
6	0.538204775	$ 12,108,974.88	$ 6,145,815.65	$ (5,963,159.23)
7	0.489277068	$ 12,108,974.88	$ 6,869,945.71	$ (5,239,029.17)
8	0.444797335	$ 12,108,974.88	$ 7,528,245.77	$ (4,580,729.12)
9	0.404361213	$ 12,108,974.88	$ 8,126,700.36	$ (3,982,274.52)
10	0.367601103	$ 12,108,974.88	$ 8,670,750.00	$ (3,438,224.89)
11	0.334182821	$ 12,108,974.88	$ 9,165,340.57	$ (2,943,634.31)
12	0.303802564	$ 12,108,974.88	$ 9,614,968.37	$ (2,494,006.52)
13	0.27618415	$ 12,108,974.88	$ 10,023,720.91	$ (2,085,253.98)
14	0.2510765	$ 12,108,974.88	$ 10,395,314.13	$ (1,713,660.76)
15	0.228251363	$ 12,108,974.88	$ 10,733,126.14	$ (1,375,848.74)
16	0.207501239	$ 12,108,974.88	$ 11,040,227.98	$ (1,068,746.90)
17	0.18863749	$ 12,108,974.88	$ 11,319,411.46	$ (789,563.42)
18	0.171488628	$ 12,108,974.88	$ 11,573,214.63	$ (535,760.25)
19	0.155898752	$ 12,108,974.88	$ 11,803,944.79	$ (305,030.10)
20	0.141726138	$ 12,108,974.88	$ 12,013,699.47	$ (95,275.41)
21	0.128841944	$ 12,108,974.88	$ 12,204,385.55	$ 95,410.67
22	0.11712904	$ 12,108,974.88	$ 12,377,736.53	$ 268,761.64
23	0.106480945	$ 12,108,974.88	$ 12,535,328.33	$ 426,353.44
24	0.09680086	$ 12,108,974.88	$ 12,678,593.60	$ 569,618.72
25	0.088000781	$ 12,108,974.88	$ 12,808,834.76	$ 699,859.87

Figure 4–17. Benefit/cost ratio

g. Equivalent uniform annual cost. In the unlikely event that your analysis includes alternatives which have unequal economic lives, or, more specifically economic lives which cannot be made to be equal it may be necessary to utilize

equivalent uniform annual cost (EUAC). Generally, the economic lives of any complex alternative can be structured in such a way that the economic lives of the various alternatives can be made equal. Since we are dealing with planning alternatives and not engineering alternatives this topic is beyond the scope of this document. It is included here simply to provide a comprehensive treatment of all possible outcomes.

4–4. Time variables

There are several time period variables which can potentially impact the analysis of a Government asset or facility. Time period variables, which are a part of an economic analysis, can be broken down into two types of variables: those whose value is mandated by external guidance and those whose value must be specified by the analyst.

a. Economic life of an asset. The economic life of an asset is the period during which it provides a positive benefit to the Government; the period of time over which the benefits of having and maintaining a facility outweigh the costs of that facility. The economic life of an asset in an analysis is limited by; the mission life (period over which the asset is needed), the physical life (period over which the asset is expected to function), or the technological life (period of technological usefulness). Usually, the economic life of an alternative will be the shortest of the three lives. See table 4–1, for guidelines on the economic life of various facility types. These guides can be interpreted as maximum lives. Local data or conditions may dictate shorter times to be used in the analysis. If the economic life in a study is shorter than the life span defined within this guidance, reasons supporting use of this shorter life will be documented in the report. Figure 4–18 contains a graphical representation of the various analysis types and the appropriate means that can be used to measure one alternative against another given differences or similarities between alternatives. The economic life of an asset is important in calculating recurring costs during the period of performance. The analyst will need to define the periodicity of major cost factors which may occur during the period of performance. Costs such as major renovations, roof replacement, HVAC replacement, communications upgrades, technological systems upgrades, and other such costs would be included here.

Table 4–1
Economic life guidelines

Equipment	Years
Automated data processing equipment	8
Buildings:	
• Permanent	25
• Semi-permanent, non-wood	25
• Semi-permanent, wood	25
• Temporary or rehabilitated (with extra maintenance at 15 years)	25
Operating Equipment	10
Utilities, plants, and utility distribution systems (including investment projects for electricity, water, gas, telephone, and similar utilities)	25
Energy-conserving assets:	
• Insulation, solar screens, heat recovery systems, and solar energy installations	25
• Energy monitoring and control systems	1
• Controls (for example, thermostats, limit switches, automatic ignition devices, clocks, controls, photocells, flow controls, or temperature sensors) • Refrigeration compressors	15

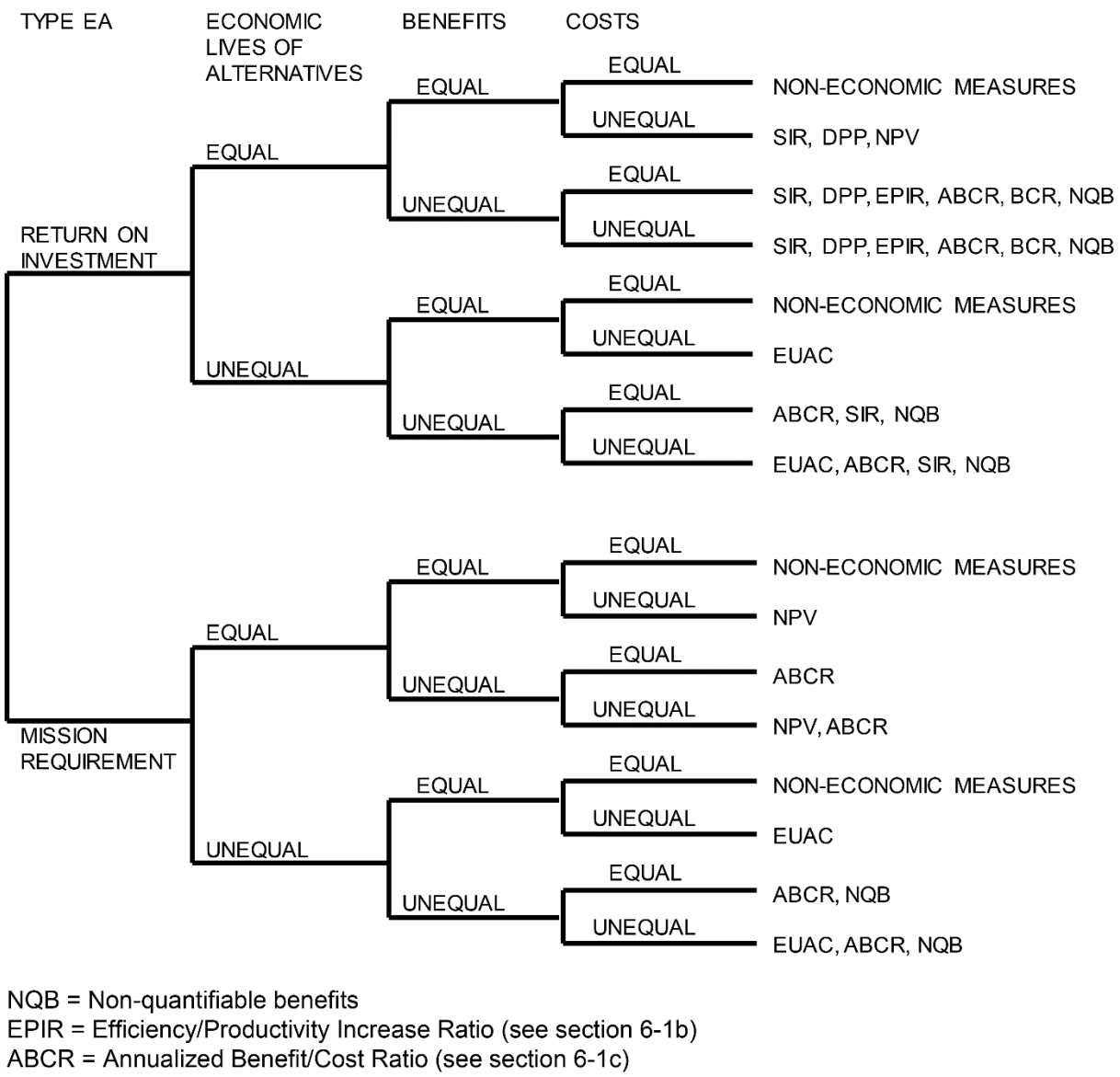


Figure 4–18. General process for determining which economic analysis method to use

b. Time period of analysis. The period of analysis is the time period over which an analysis of the costs and benefits of the various alternatives will be collected and analyzed. This period is inclusive not only of the economic life of the facility but also of the period of construction/renovation/relocation for that facility. Generally, the Government assumes that the economic life of a facility is equal to a maximum of 25 years. The period of construction, renovation, and relocation will vary based on the complexity of the facility under consideration but is generally limited to one or two years. Stated differently, the time period of analysis for most facilities is generally either 26 years (25 years of facility life and a year of construction/renovation) or 27 years (25 years of facility life and a 2-year construction/renovation period). Alternatives of an analysis must have the same period of analysis. Example: If an analysis compares renovation of an existing facility against new construction of that facility. The economic life of the renovation alternative can be equated with that of the new construction alternative through successive renovations. Stated differently, the analysis may need to include the immediate renovation of the existing facility and a substantial renovation of that same facility in year 15 of the analysis to equate the economic life of the renovation alternative to that of the new construction alternative.

c. Physical life of an asset : The physical life of an asset is period of time over which the asset physically exists. In some cases, the physical life of a building or facility can last into the hundreds of years if properly maintained. The Government has in its inventory buildings which date from all periods of history up to and including the Revolutionary period. This time period variable is important in the calculation of depreciation and the residual value of an asset. Discussion of these terms can be found in paragraph 4–7. In most cases the physical life of a building is limited to a maximum of 50 years. A new building must be designed with a minimum life of 40 years; block number 10, description of proposed construction of the DD 1391 reads, "Facilities will be designed to a minimum life of 40 years in accordance with DOD's Unified Facilities Code (UFC 1–200–02) including, energy efficiencies, building envelope,. and integrated building systems performance."

d. Start year. The start year is the first year in which initial investments are made, the year in which construction starts, and the first year in which costs occur. The start year is the first year of the period of analysis. Example: If we are analyzing various alternative means to provide for 250 barracks spaces and the project is listed as a 2021 project in the future year defense program (FYDP) then the start year could be calendar year 2020 or 2021 depending on when construction begins.

e. Base year. The base year of an economic analysis is the year to which all costs and benefits will be discounted. This year can be either before or the same year as the start year defined above. Normally, the base year will be the year in which the EA is performed. From a purely mathematical viewpoint, the choice of a base year will not affect the rankings of alternatives. Example: If we are conducting an economic analysis of an FY21 barracks project during January of 2017 then the base year can be any year between 2017 and 2020 but will probably be set to 2017.

f. Discounting convention. There are three methods of discounting costs: end-of-year, middle-of-year, and beginning-of-year. End-of-year means that the cost or benefit occurs at the end of each year; middle-of-year factors are used for most of the costs or benefits occurring in a project; and beginning-of-year means that the cost or benefit occurs at the beginning of the year. If costs or benefits occur evenly during the year, it is customary to use middle-of-year discounting. Figure 4–19 is used for middle-of-year discounting. Figure 4–20 and 4–21 are used for beginning-of-year and end-of-year discounting, respectively.

$$PV = Fn\left(\frac{1}{(1+i)}\right)^{n-0.5}$$

Figure 4–19. Discounting (middle-of-year)

$$PV = Fn\left(\frac{1}{(1+i)}\right)^{n-1}$$

Figure 4–20. Discounting (beginning-of-year)

$$PV = Fn\left(\frac{1}{(1+i)^{n}}\right)$$

Figure 4–21 Discounting (end-of-year)

4–5. Inflation

Inflation is defined as a consistent rise in the cost (prices) of goods and services over time. Inflation guidance is provided below based on OMB Circular A–94. To discuss inflation concepts, it is necessary to understand the concepts of constant and current dollars.

a. Constant dollar convention. Constant dollars indicate constant purchasing power in terms of the dollar value in the base year of the EA. An EA is said to be in constant dollars if all costs are adjusted to reflect the level of prices for the base year. Conversely, a constant dollar analysis may not be adjusted for nominal inflation. For example, if the annual maintenance cost of a project is $20K in the base year, it will be $20K in each year of the analysis.

b. Current dollar convention. Current dollars are expressed in the actual amounts which are expected to be incurred at the time of expenditure. Current period costs are simply expressed as the actual amounts paid out and future costs are expressed in amounts expected to be paid in their year of occurrence. By this definition, future costs must include an adjustment for inflation.

(1) In most cases, use of the current dollar convention is used for lease versus purchase analyses per or other in- stances where price/cost information is only available in inflation adjusted dollars. Most MILCON EA's will be performed using the current dollar convention; this convention is the default setting in ECONPACK.

(2) The most common inflation indicators utilized are the Tri-Service Military Construction Program and, to a lesser extent, the consumer price index (CPI) and the producer price index (PPI). These indexes are utilized to express nominal inflation in the market. Nominal inflation is defined as the average level of inflation over a large number of products and services.

(3) The analyst should be careful since use of a single index or convention to define inflationary movement in all products and services utilized to bring about the completion of a project ignores an important aspect of inflation: the prices of all services and products do not move in tandem. While it is possible that the price of steel and the price of concrete may rise by the same amount over the next 5 years, there is no evidence that it will. The analyst needs to ensure that, when a significant deviation exists, the level of anticipated inflation for different materials is factored into the cost of the project. (For an example, annual cost increases for fuel and medical care expenses have historically risen by percentages which are significantly higher than nominal inflation rates. As a result, an analysis which includes either fuel or medical costs may also include an inflation index which is specific to medical or fuel costs.)

(4) Only when the analyst has sufficient information indicating that the price or cost of a particular category will rise faster than all other costs should the analyst engage in creating a cost specific inflation schedule. In all other instances, the analyst should make use of the predetermined general inflation schedule contained in ECONPACK.

(5) There is usually a time gap between the present (when the EA is performed) and the start year (when costs are first incurred). This means that costs estimated at the present time may have to be inflated to the start year. For example, if the period of analysis begins in 2010, but cost estimates from 2008 are obtained, these costs must be inflated from 2008 to 2010.

4–6. Deflation

Deflation is the opposite of inflation; a situations where costs decline in price level over time. Accounting for deflation within the project will be performed in the same manner by which inflation is captured except in reverse.

4–7. Depreciation

a. Depreciation is defined as the loss of value over time due to the use of an asset. It is the monetization of nominal "wear and tear" on the asset or facility when employing that asset in the nominal day to day operations for which it was designed. See examples 1 and 2.

(1) *Example 1.* The Army constructs a new barracks building to house Soldiers during basic training. It is estimated that with appropriate maintenance and repair, the building will be of use to the Army as a barracks building for 40 years.

After 1 year of housing Soldiers, and after accounting for a year's worth of maintenance and repair the building will be worth 2.5 percent less than when it was new (1 year out of 40 years is equal to 2.5 percent of the buildings life). Stated differently, if a building has a 40–year economic life, by utilizing the building, each year 2.5 percent of the life of that building is consumed. The residual value of a building is equal to the value of the building less depreciation.

(2) *Example 2.* Borrowing from the example above. If a building with a 40–year life depreciates 2.5 percent for every year, then the residual value of the building is equal to 97.5 percent of the initial value of the building after the first year. After 5 years, the residual value of the building is equal to 87.5 percent of the initial value of the building. In the 39th year of the buildings life, assuming appropriate operations and maintenance, the residual value of the building is equal to only 2.5 percent of the initial value of the building.

b. In accordance with DOD 7000.14, Volume 4, Chapter 6, the salvage value of a building is defined as the commodity value of the building components once the building has been demolished. The DOD does not include estimated salvage values into its calculations of real property life-cycle costs. Do not include salvage values. Note: the FMR section cited above uses residual value interchangeably with scrap or salvage value. Within this DA PAM, the term residual value is used to denote the remaining useful value to the Government of the asset after accounting for depreciation. As utilized above, this definition of residual value represents the remaining value of a barracks building in its use as a barracks to the Government.

c. The only costs to be included into an EA for MILCON alternatives are for costs which impact cash flow or subject the Government to an expense; costs such as labor, materials, supplies, and utilities are included whereas depreciation is not. Depreciation of an asset is included into the analysis of alternatives in the calculation of residual. This contrasts with standard accounting practice in the private sector. The depreciation write-off of a long-term asset is an accounting expense. The benefit to the corporation or business is that a firm can deduct its depreciation allowance from net income before paying taxes. In other words, depreciation write-off is used only when an income tax structure exists. The Government does not pay income taxes; therefore, depreciation write-offs must not be included in analyzing Government investments.

d. The Government does account for the residual value of a building or other assets but only as a onetime valuation at the end of the period of analysis and then only if the asset in question will be disposed of or scrapped. (For an example, assume that we are analyzing the new construction barracks alternative defined above against the renovation of a 20-year-old existing barracks building. The analysis period to compare these two alternatives is 20 years. If the existing barracks building has a 40–year life, then at the start of the analysis period it is 50 percent depreciated and will be fully depreciated at the end of the analysis period or the 20th year of the analysis. The renovation alternative will not be able to recognize any residual value of the building in question at the end of the analysis period. At the end of the 20–year analysis period, the new construction alternative will have 20 years of residual value remaining and should recognize a residual value equal to $4.5 million (((\$10m-\$1m)/40 years)*20 years). (See fig 4–21 for an example.)

e. It is common to calculate the residual/terminal value using straight-line depreciation. A residual/terminal value can be calculated using the double declining balance method or any other depreciation schedule commonly used in accounting practice. For the purposes of this document, only straight-line depreciation will be illustrated.

Suppose a building has an initial cost of $I M with a physical life of 40 years. The economic life is 25 years. The value of the building will decrease by $I M / 40 years = $25K/year. At the end of 25 year economic life, its residual/terminal value is calculated as shown:

($25K/year) (25 years) = $625K

Figure 4–22. Example residual/terminal value

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f. The residual value is a product of the original value, an inflation index, a discount factor and a depreciation factor. The original value or construction value is the calculated amount necessary to construct the project. . The inflation index is needed (when dealing with current dollar values) to adjust the value of the asset to account for inflation. The discount factor is necessary to deflate the value of the asset to a common point so as to analyze it against other alternatives. Lastly, the depreciation factor represents the cumulative depreciation at any time within the project life. As with all other calculations, the ECONPACK software automates this process. All that is required is for the appropriate values to be entered into the correct fields.

Chapter 5
Description and Estimation of Costs

5–1. Definition of costs

A cost is the value, measured in dollars, of each resource required to implement an alternative. Cost categories can include materials, labor, maintenance, and supplies, and it includes the time value of money or cost of capital spent in procuring these goods or services. A cost is the market determined value of a resource.

a. Analysis. A proper cost analysis of an operation requires that the amount and timing of each cost outlay be determined for each alternative. Costs incurred in implementing and in maintaining the project over the project life or period of analysis must be calculated and included in the total project cost (life-cycle costing).

b. Costs can be quantitative or qualitative. Quantitative costs are those costs related to the acquisition or use of resources such as labor, material, equipment, and supplies. These costs can be estimated and, in the EA, have a definite dollar value. Qualitative, or non-monetary costs, are those costs which, lacking denomination in monetary units and lacking an easily definable financial proxy, must be presented as qualitative assessments rather than numerical or monetary valuations. Costs such as increased or decreased morale, convenience, unit integrity, and changes in utility are all intangible. Significant non-monetary impacts of project implementation must be presented to the decision makers so that all aspects of an alternative's impacts may be factored into decision making.

c. Example. Assume that we are analyzing the construction of a new Unaccompanied Enlisted Personnel Housing (UEPH) project. The garrison has designated two possible sites on which to construct this building. The first site has easy access to all utilities but is removed from the restaurants, Post Exchange (PX), commissary and other entertainment venues on post. The second site will require an upgrade to the existing electrical line and will require a new communications line but the site is less than a 100 yards from the PX, commissary and other entertainment venues. While the quantitative analysis will need to account for the variation in utility costs, the qualitative analysis will need to discuss the variation in quality of life provided by proximity to the various entertainment venues on base.

5–2. Life-cycle costing

It is essential that all costs associated with a viable alternative are included into an analysis. An EA helps the decision maker allocate resources effectively but is only effective when all direct and indirect resource costs associated with each alternative are considered. The EA must analyze the impact of all costs incurred during the life span of the project. This step is important because initial investment costs can be misleading. For example, renovation may require less of an initial capital investment, but its annual operations and major repair costs may be much higher than similar costs with other alternatives.

a. An investment decision is a decision to commit different resources, including funding resources, to achieve the objective of the project. Construction of a maintenance shop, for example, involves not only the construction cost, but also: the allocation of land, the commitment of funds for personnel, operations, and routine maintenance, various recurring and non-recurring costs during the facility life and the possibility of a cost to demolish the shop at a future point in time.

b. While the foregoing discussion is not exhaustive, it does represent the concept of life-cycle costing: the incursion of various costs and the realization of benefits in differing amounts at different points in time.

c. The goal of an EA is to provide the decision maker with essential information necessary to achieve the project objective that most efficiently allocates resources. The EA gives an unbiased picture of the full life-cycle resource and benefit implications of each alternative. Once this information is available, a decision can be made to achieve the best level of national defense possible within the constraints of the Army budget.

5–3. Cost elements

All cost elements of a project must be considered and included in the EA. An exception to this rule is the category of "wash costs" discussed in paragraph 5–6. What follows is a list of the cost categories generally found in MILCON EAs. This list is not meant to be comprehensive, but is rather an introduction to common cost categories. No one EA is ever likely to contain all of these costs. They are listed to ensure that the analysts consider all potential costs. If an analyst realizes that a cost category which is not a part of this list is incurred by one of the alternative courses of action then the analysis should include the cost into the EA. Analysts perform the EA as representatives of the U.S. Government and the taxpayer; therefore, they should include all relevant costs.

a. Construction contract costs. Construction costs, also referred to as "first costs" are usually the largest cost items included into an economic analysis. These are the costs to construct a new facility. All costs to construct the facility are included: costs to design the facility in question, construction costs, contract administration, inspection, supervision, and

any other costs associated with the construction process. Sources of data for these costs include the division and district corps offices; installation, Directorates of Public Works (DPWs); and historical data for similar projects.

b. Renovation costs. These are major costs that occur initially to renovate a facility. Cost estimates can be obtained from the DPW, district and division offices, and cost estimating guides.

c. Maintenance costs. These are annual recurring costs of normal maintenance for a facility such as those normally done through service orders. This category also includes ongoing maintenance such as that done with standing service orders and any periodic maintenance such as a bi-yearly inspection of a facility. Preventive maintenance also is included. Any maintenance and repair costs not considered a major repair or replacement falls into this cost kind. Data for these costs can usually be estimated best by the installation DPW based on historical records.

d. Periodic repair and replacement costs. These costs are major one time or periodic costs occurring during the analysis period of the project. Costs to replace a roof, the exterior finish of a building, the floor covering, the air conditioner, or heating plant and costs to repaint the exterior are typical examples for this category. Good data sources for these costs are the DPW and cost estimating guides such as Means and Dodge.

e. Utility costs. Energy source costs such as gas, oil, coal, electricity, and wood are included here. Water and sewer costs also belong to this category. Any communications or telecommunications service costs can be included. This cost category does not include construction and maintenance costs of utilities plants or distribution lines. Data can be obtained from the DPW and companies providing these utilities.

f. Lease cost. This is the monthly or yearly charge to the Government to lease an asset as opposed to the purchase of that asset by the Government. Estimates for facility leases can be obtained from corps district real estate offices, the General Services Administration (GSA), and commercial firms in the locale. Equipment lease rates can be obtained from local or national leasing companies.

g. Administration costs. These costs are salaries for the facility management staff (such as the housing office personnel) or for the contract manager in the case of a lease. It does not include the normal costs of occupants in management of their space. These costs can be obtained from the DPW.

h. Equipment costs. Equipment includes material handling, production lines, central or domestic laundries and kitchens, power or heat generation and distribution, fuel handling, utilities distribution, and sewage treatment. Data can be obtained from the DPW and DOL.

i. Furnishings costs. This cost category includes the furnishings and their replacement, maintenance, repair, storage, distribution, security, and all other property management functions. The DPW and DOL are possible sources for cost data.

j. Services costs. This cost category includes costs for services such as snow removal, trash hauling, security, custodial, and pest control. Data sources are the DPW and DOL.

k. Personnel costs. These costs are for military, civilian, and contractor personnel. These costs are those labor costs typically associated with the operation of facilities or vehicles associated with the alternative. Salaries can be obtained from the Army Military Cost System model (AMSOC-lite) or the local resource management (comptroller's) office. For production-type facilities, this cost can be a crucial part of the EA, as different alternatives may allow different production line designs that require different numbers of personnel.

(1) Example, consider that a military function where top secret information is processed is housed in facility with a second military function that does not process secret information. The status quo condition requires that all personnel be escorted so that they do not enter classified areas. As a result, there are personnel costs associated with the status quo condition. The status quo condition is being compared to a new construction alternative that would eliminate this personnel cost.

(2) Another example, for civilian personnel, the labor costs are calculated by using the current pay rate as published, plus any contribution by the Government for retirement, location differential, disability insurance, health insurance, life insurance, and, where applicable, social security. Costs associated with benefit costs, costs of labor other than the base rate of pay, should equate to 26 percent of the base pay rate (retirement=20.4 percent, insurance=3.7 percent, and bonus, compensation, unemployment, and awards=1.9 percent). In some locations, there would be increases to this 26 percent to reflect location adjustments.

(3) Lastly, an example of the cost of military personnel is calculated by using the standard rates set by DOD for expending military personnel services. These rates include basic, incentive, and special pay, plus certain other expenses and allowances paid from Military Personnel, Army appropriations. (See DFAS-IN 37–1 for more information.) Adjustments must be made to reflect the Government's contribution to retirement and other costs by multiplying by the percentages shown in table 5–1.

Table 5–1
Government contributions for military personnel service (based on percentage of gross pay)—Continued

Allowance	Officer (%)	Enlisted (%)
Retirement	26.5	26.5
Other benefits	8.0	23.0
Total	34.5	49.5

(4) Contractor personnel costs should be calculated using Department of Labor general wage determinations published for the trades to be engaged in the project under review. (See Federal Acquisition Regulation (FAR) 22.404–1 and 22.404–2 for more information on industry wage determinations.)

(5) Costs for pay and employee benefits of host country nationals or third country national employees must also be included when applicable. In general, pay and benefits for foreign nationals can be obtained from that countries Government or the labor rates of U.S contractor personnel can be adjusted by a factor to account for wage differences.

(6) The military pay rate of host country officers shall be increased by 61 percent over base pay and for enlisted personnel by 79 percent over base pay.

l. Allowances. These costs include basic allowance for housing (BAH), overseas housing allowance (OHA), temporary lodging allowance (TLA), and temporary duty. Information on these allowances can be obtained from the DPW and the Finance and Accounting office.

m. Land. This is the cost to acquire land from a private sector source and costs of easements are in this category. In CONUS, these costs will be obtained from the corps district real estate office. OCONUS land costs are based upon local procedures.

n. Residual/terminal value and demolition costs. The residual (or terminal) value of a facility at the end of the period of analysis represents the market value of the structure at the end of the project life. This valuation is the value left in the structure between the end of the project life of the structure and the end of the physical life of the structure. The residual/terminal value is estimated on the basis of use, obsolescence, rehabilitation possibilities, and market value. Estimates of these costs can be obtained from the DPW, district real estate offices, and commercial real estate firms. Garrison level estimates of costs can be used in lieu of estimates by USACE engineers. For OCONUS projects, the analysis must include estimates which conform to the terms of the SOFA. See paragraph 2–6. Guidance for overseas commands and installations for a discussion of this topic.

(1) For an example, assume that we are analyzing renovation of an existing HQ building against construction of a new building. Assume further that the current HQ building has a remaining life of 30 years. Lastly, assume that the new construction alternative has a 40–year life. The economic analysis will analyze both alternatives over a 25–year period. In analyzing the renovation alternative, the value of the 30 years of remaining life will be reduced for each year of the analysis until only 5 years of useful life remaining after year 25 of the analysis. Likewise, the new construction alternative will have 15 years of useful life remaining after year 25 of the analysis. The analysis must include values for both remaining lives into the analysis.

(2) For a complete discussion of the calculation method for residual value and depreciation see paragraph 4–7.

o. Transportation/travel costs. If an alternative includes transporting personnel, goods, or equipment, the cost must be an input to the analysis. Household goods costs are included here as are the costs of transporting personnel, equipment or materials to and from a facility, contract costs to obtain such services would also be included here. This cost includes costs of vehicle and operating personnel in addition to any cost for transported personnel such as student trainees. Data sources are the DPW, DOL, and local private transportation firms.

p. Communications costs. This is the cost for purchasing and installing communications equipment. The annual costs of communications services are also included. A possible data source is the local USAISEC office.

q. Imputed insurance. For analyses involving leases, the cost of insurance to the contractor is included. The Government is self-insured and insurance costs are used only when leasing is one of the viable alternatives. Sources for this data are Building Owners and Managers Association (BOMA) and local insurance firms.

r. Imputed taxes. For lease analyses, property taxes are included. Tax amounts can be obtained from the district real estate office and the local assessor's office.

s. Imputed land. For lease analyses, the cost of Federal land is included. This cost should be based on the fair market value of similar commercial properties in the same or similar localities and can be obtained from the district real estate office and the local assessor's office.

5–4. Cost elements applicable to the economic analysis for housing

a. Each economic analysis includes many estimates of operating characteristics and costs. Since estimates seldom identify the exact outcome, it is necessary to identify expense items and cost kinds that may be significantly different from the estimate. Include the impact of these potential differences and their likelihood of occurrence in the analysis. Maintaining as much standardization as possible will aid reviewers of economic analyses. This methodology will also help to communicate more effectively to higher levels of command and to Congress.

b. Cost kinds applicable to housing alternatives.

(1) *Equipment procurement costs.* These are nonrecurring costs that may be required to support a variety of cost kinds. This expense item covers the purchase price, transportation, and installation costs. It includes such items as housing equipment replacements, office furniture, office equipment, maintenance equipment, vehicles, and communications equipment, when the equipment is purchased to support a specific housing alternative or housing management operation.

(2) *Treatment of inherited assets.* Investment for the project under study may consist of assets to be acquired, plus assets already on hand; (inherited assets). When an inherited asset is being used or is intended for use on a housing alternative, the residual value at the base year (measured by market price, alternative use value, or amortized value) will be included in the investment cost. The value of an inherited asset intended for sale will be included in the investment cost, since it deprives the Government of the expected income from the sale. An inherited asset released for sale by the proposed alternative will have its expected sale value deducted from the investment cost. The value of an idle inherited asset that has no other use, and is not intended to be sold, will not be included in the analysis. Each inherited asset must be evaluated on its own merits and in terms of whether its use in connection with the alternative being considered will cause future expense to the Government. Documentation of alternative use is necessary for each existing asset employed or replaced. When no documentation is possible, the analyst and the reviewer must estimate the commercial value of the assets to be inherited. Housing operations typically inherit assets such as land, existing DUs and office facilities, household furnishings and office furniture and equipment, although other articles occasionally are inherited. DUs that are part of a renovation alternative should be included with a physical life span of 25 years, and the cost of an additional renovation at the 15–year point should be included

(3) *Other personnel costs.* The sum of personnel costs that pertain to performance of the function under consideration, and that are not included in paragraph 5–3*k*. Some examples are travel, per diem, moving expenses, cost of personnel training chargeable to the operation, home leave, Government household furnishings, environmental and morale leave, and health costs in some overseas locations.

(4) *Basic allowance for housing.* This expense item includes the BAH allowance that is provided to military members who live on the economy. It should be included for each year that it will be required, except for years when this cost is identical for all alternatives. (See "wash costs" in paragraph 5–6 if the cost is the same for all alternatives.)

(5) *Other allowances for quarters.* This is the cost of all other allowances for quarters. For an example, are overseas housing allowance, living quarters allowance for certain civilians on overseas assignment, Family separation allowances I and II, temporary living allowance (TLA) after permanent change-of-station moves, and any others that may apply to military or civil service personnel or host country national employees.

c. Most EAs of housing alternatives focus on two or more alternatives. The six alternatives found most frequently are as follows:

(1) Use of private rental housing assets.

(2) Use of private rental housing assets, combined with Government rental guarantee.

(3) Government lease and Government operation of a housing complex, such as an apartment complex or housing development.

(4) Government–leased housing operated by a contractor.

(5) Government–owned and Government–operated housing.

(6) Government–owned and Government–operated housing facilities.

5–5. Cost estimation methods

Perhaps the most difficult phase of an EA is the estimation of costs. This part of the EA is crucial because the results will only be defendable to the extent that the cost estimates are reliable. Estimates can never be 100 percent precise as they are made several years before the costs will actually occur. Between the time of the estimate and construction, several changes may occur, including the rate of inflation of cost variables and/or construction standards or guidance. Standards such as level of maintenance or the frequency of maintenance for a facility may vary in the future. Estimates must be as precise as possible given the constraints on the analyst in performing the EA, however, contingencies must be made for these unknowns.

a. The level of accuracy of a cost estimate is directly related to the amount of information collected. As the amount of information collected increases so does the accuracy of the analysis. There is also a direct relationship between the cost of an analysis and the level of accuracy. As the level of accuracy increases so does the cost of the analysis.

b. Precision is usually obtained by acquiring as much detailed data as possible. Most cost estimates are based on historical data. The analyst chooses the proper level of detail and accuracy in the estimates given the time allowed to obtain the estimates. There are three levels of detail and accuracy at which a cost estimate can be performed.

(1) *Order-of-magnitude estimates.* The accuracy of these estimates is very low and can differ from the actual cost by as much as 50 percent. These are used when there is not enough time, funds, or both to do a detailed analysis, or when the magnitude of the cost is so small that large inaccuracies will not be a determining factor in the analysis.

(2) *Good estimates.* Good estimates are those for which accuracy is about 10 percent of the actual cost.

(3) *Detailed estimates.* These estimates will normally be within 5 percent of the actual costs. They are often derived from detailed plans and specifications or from accurate historical records. These estimates should be used when possible to ensure the validity of the analysis.

c. Cost estimates must be made with care and with full knowledge of their limitations. The limitations (assumptions) must be fully documented in the EA report. The accuracy of the estimates must be assessed and tested for impact on the analytical results by use of cost sensitivity analyses. There are five primary methods of cost estimation described below. Methods of cost estimates are to be differentiated from levels of accuracy. While each analysis method is more suitable to a given level of accuracy, all analysis methods can be employed to support all accuracy levels.

(1) *Analogy method.* This is perhaps the most widely used method. It is based on the idea that projects which are similar should have similar costs; at a minimum the cost structure of similar projects should provide a basis from which to estimate other projects.

(a) This method is used often in estimating facility acquisition or renovation costs. Historical construction costs for similar facilities on the installation or in neighboring communities can be used. Estimates of annual recurring costs are often obtained by this method when the analyst can obtain current, accurate records of costs such as roofing lives and repairs, custodial costs, and energy consumption for similar types of facilities. Application of these cost records requires expert judgment and experience by the analyst and the DPW staff.

(b) Example, the project in question analyzes the construction of a new performance hall for the Army's band versus the renovation of the existing facility. It is a foregone conclusion that the Army does not build too may performance halls or theaters. Through research you are able to find a performance hall similar in size to that of the proposed facility that was built 2–years ago at a nearby university. You utilize the cost of this facility as a baseline to estimate the cost of a newly constructed performance hall for the Army. This methodology generally requires the analyst to make some judgments when using this method. The key is to fully document all information utilized in the EA.

(2) *Budgeting or Industrial engineering method.* In order to utilize this methodology, the analyst must have extensive knowledge of the system, operating processes, and organization being analyzed. The analyst or cost estimator must be able to divide the system into its components and generate estimates for each component. This breakdown allows the analyst to determine which costs are known and where effort must be directed to obtain estimates. This process also allows an emphasis on estimating costs when little information is available. This methodology is commonly used in projects involving production-type situations such as maintenance shops and ammunition production facilities. However, the principles behind it can be used for any type of analysis. For some system components, industrial engineering techniques such as work measurement and time-and-motion studies may be needed to make the estimates. For other system components, the analogy method may be used. Once the costs have been estimated for each lower level component of the system, they are combined to obtain the estimate for the whole system. Because this method is so detailed, it can result in very accurate estimates. However, it can be very costly to obtain such estimates. When detailed data exists or is easy to obtain, this method is the best one.

(3) *Parametric method.* In this method, the total cost of an alternative or some part thereof is based on specified physical and performance properties and their relationships to component costs. In other words, an equation or system of equations is created which estimate the cost of project based on a few variables. The term "parameter" is defined as a cost-related explanatory variable that may assume various values during actual calculations. A parametric estimate depends directly on the ability of the analyst to set up relationships between the attributes that comprise the alternative. The analyst must select and describe the cost-influencing factors of the alternative.

(a) For an example, the construction of Family housing involves (among others): the number of stories; the number of DUs in the building; the number of bedrooms, baths, dens, and recreation rooms; floor area of the various rooms; garage size; and lot size. It is reasonable for the cost estimator to describe an equation which multiplies the square footage of a structure by a square foot cost to achieve a baseline for that facility. By extension, the cost for several facilities could likewise be estimated using this type of algebraic estimation technique.

(b) Ease of estimation and accuracy of estimates increase with the increase in number of actual combinations for which prices are known. Given many combinations, the analyst can develop a valid cost estimation relationship. Statistical techniques such as regression analysis can be used to develop equations that describe such relationships.

(4) *Actual cost method.* This method depends on the production of development of a prototype or a previous facility which mirrors the facility being considered for construction. The method uses the actual cost of the previous facility and adjusts that cost for inflation, labor efficiency, material costs, technological changes and other factors. This method is generally employed near the end of a production run. For an example, the Government wishes to construct 25 child development centers (CDCs) in CONUS locations. It is reasonable to assume that the cost to construct the fifteenth CDC will be largely similar to the cost to construct the fourteenth. Taking the cost of the fourteenth CDC and adjusting for changes in time and location should provide a reasonably accurate cost for the fifteenth CDC.

(5) *Expert opinion method.* Use of this method is contingent upon two circumstances. First, the project in question must be of sufficient complexity and time available to produce the cost estimate is limited so that the combination precludes development of a cost estimate by any other method. Secondly, the availability of sufficient expert opinion to provide an average or consensus opinion on the cost. The individuals providing the opinions must be experts in their field and their expertise must be directly relatable to the estimate being given. For example, an expert in chemical engineering should not be queried on the costs associate with the construction of a ballistics laboratory unless that chemical engineer has had 20 or more years of experience in the construction of laboratory spaces. The need for an average or consensus opinion refers to the need to obtain multiple opinions on the estimated cost. Generally, the Dephi technique or a similar technique should be employed whereby the opinion of multiple experts is obtained and then averaged or weighted to arrive at a consensus point estimate.

5–6. Sunk and wash costs

a. A "sunk" cost is one that will occur before the period of analysis. Sunk costs are past history. They will have no bearing on the future and are therefore disregarded in the life-cycle cost of the EA. Sunk costs may be discussed in the "Background" section in ECONPACK.

b. A "wash" cost is one that occurs identically for all alternatives. Wash costs can normally be excluded from the EA since they will not affect alternative rankings or the SIR. However, if the EA results will be used to represent total discounted dollars needed or to be spent, wash costs should be included. Wash costs need to be discussed in the "Assumptions" section of ECONPACK.

5–7. Incremental costs in a housing analysis

a. Incremental costs are cost increases or decreases that result from a change in operations. These costs are often stated in terms of cost change per unit of change. They are also sometimes stated in terms of total cost of a change in operations. Changes in costs can result from such items as the addition of DUs, personnel, consumption of more water, or added cost to mow the lawn more often than under prior methods. If the cost of coal is $100, and incremental cost per ton of coal for heating is $20 for a decrease in consumption from 150 to 100 tons per month, but only $15 per ton for a decrease of 20 tons per month, the cost saving in total operations would be $3,000 for reducing 50 tons of consumption, and only $50 for reducing 20 tons per month. Each alternative nearly always alters the level of portions of the operation. These cost changes are incremental costs or savings.

b. Economic analyses should be computed on the basis of cost differences between current operations and those proposed by an alternative. Economic analysis is not a budgeting process, but an analytical process. A budget estimates total cost of operating an organization and considers only the selected alternative. An economic analysis is a decision point tool. It includes only those costs that change, and it considers the cost of several alternatives. It includes the costs of all organizations that are to contribute to the changed process.

c. The objective of an economic analysis is to identify the best course of action. Usually this can be done effectively without calculating the total cost of any alternative. Financial aspects of the decision rest entirely on the need for additional funding and the obligation of more resources. Nonfinancial considerations affect the decision, but only added costs to be incurred and cost reductions to be gained are relevant.

d. Economic analyses are often reviewed by persons who are not familiar with the concept of incremental cost. These persons know of many costs that must be incurred to support a wide variety of activities; they expect identification of these costs in the economic analysis report. The report must be complete; it should attempt to forestall as many questions as possible. One way to reduce questions and to show competence and quality analysis is to include comments in the report. Typical expense items that would not incur increases should be identified. This informs the reviewer that the preparer knows the expense item exists. It also shows that the impact of the alternative on the expense item was considered, and that the impact was negligible.

5–8. Level of detail

One important qualification or cautionary note inherent to any cost analysis is the consideration of the level of cost savings versus the level of analysis precision and detail. If the amount of cost savings attributable to an alternative is small, the level of detail must be fairly substantial and account for most, if not all, factors that could impose costs upon the project. An economic analysis which contains detail sufficient to capture small cost variations between alternatives may prove to be too costly or time consuming for the project's budget or schedule. This detail should be undertaken only when necessary. In cases such as these, an attempt should be made to capture any non-monetary considerations which may help differentiate between alternatives.

Chapter 6
Description and estimation of benefits

6–1. Beneficial impacts

The main benefit to be derived from a MILCON project is fulfillment of the stated project objective. This is a benefit common to all alternatives in the EA, and its inclusion in the EA calculations would not affect the ranking of the alternatives. So, dollar quantification of the major benefit is unnecessary. Emphasis is, therefore, placed on the benefits of the alternatives. Dollar quantifiable benefits (other than meeting the stated project objective) of each alternative are treated as cost offsets for that alternative. In general, there are four types of benefits commonly found in MILCON projects: direct cost savings, efficiency/productivity increase ratio (EPIR), other quantifiable output measures and non-quantifiable output measures.

a. Direct cost savings. Typically found in return on investment EAs, these savings are associated with the implementation of a less expensive solution to an existing need than the solution currently employed. These savings can result from modernization: a new technology becoming available, renovation, or constructing a new facility. Reference the LED vs. CFL analysis contained in figure 4–7. The key aspect is that savings will accrue due to the adoption of some new way of conducting operations. This usually takes the form of a reduction in recurring operation and maintenance (O&M) costs. That is, after an initial investment, the funding level needed for the facility and its function will be reduced in future years. When direct cost savings are the reason for performing an EA, a return on investment EA is performed (see para 3–3). In figure 4–7, direct cost savings are the net difference between the O&M costs of the two alternative lighting solutions. The BCR is calculated by dividing the total discounted savings by the total discounted investment costs. When the NPV of these savings exceeds the investment, the project "pays for itself" over the period of analysis and is self-amortizing. The self-amortization is demonstrated by an SIR greater than 1.0. Sometimes a project will not produce an SIR greater than 1.0, but will produce a partial self-amortization of interest to decision makers.

b. Efficiency/productivity increase ratio. Often projects such as modernization, rehabilitation, and consolidation projects increase an operation's efficiency or productivity. These increases are very beneficial and should be included in the BCR analysis when they exist. Benefits of this type are often confused with direct cost savings because they are easy to quantify in dollar terms. However, they are not equal, and the analyst should understand the basic difference.

(1) An increase in efficiency or productivity implies only one result: the ability to do more work within the existing manpower and funding levels. One way to translate an efficiency/productivity increase into direct cost savings is to effect a reduction in force which lowers the required personnel funding level. The other way is to use the same manpower level to meet an increased workload requirement.

(2) An efficiency/productivity increase that translates into a labor/time savings of 2–man years is a benefit whose value can be defined as what it would cost the Army to pay for an additional 2–man years of labor. This cost should be accelerated by the appropriate rates for leave and fringe benefits because the value of the benefit should reflect the actual total cost to the Army of providing 2–man years of work. This classification of beneficial impact is generally found in projects which are centered on production line activities and therefore limited to AMC projects.

(3) Example: Assume that retrofit of Apache helicopter transmissions is carried out in two facilities which are approximately 25 feet apart. The fact that each transmission must be transported between facilities requires work on the transmission to be stopped, the transmission to be prepared for transport, unpacked before work can begin causes the Government to incur an additional cost over an ideal production line. In addition, climate conditions can cause flash condensation on the transmissions which requires additional time before work can begin on the transmission. By building a new integrated facility, the Government would eliminate the time required to prepare and transport the transmissions between the two buildings. The value of the time lost due to the need to transport these transmissions between the two facilities is a benefit of a newly constructed, purpose built facility.

c. Other quantifiable output measures. Many MILCON projects, especially industrial projects, have a stated goal defined in terms of required outputs; these goals may not always be quantified or they may not be expressed in units easily

convertible to monetary units. In most cases, the analyst can define a quantifier or a proxy which allows these benefits to be presented in a manner meaningful to the decision maker. Generally, these benefits are presented in terms of an annual benefit/output measure (ABOM). The ABOM is a quantified statement of expected yearly output for the alternative under investigation. A basic example of ABOM measures is given in figure 6–1. New construction and modification comparison example. Other examples of ABOM are:

(1) Number of vehicles overhauled per year.
(2) Number of miles of road resurfaced per year.
(3) Cubic feet of sewage treated per year.
(4) Number of Soldiers trained per year.
(5) Kilowatt-hours of electricity produced per year.
(6) Antennas.

Assume that because of a regional consolidation, an Army tank maintenance facility is now responsible for all corrosion control maintenance for all Army tanks in the northeast United States. Further assume that the facilities engineers have done a detailed feasibility and concept study and decided that there are only two viable alternative methods of satisfying this operational requirement: the first alternative is the new construction alternative: demolish the old space and build a new, highly efficient, semi-automated corrosion control facility. Expected life is 25 years. Suppose there are 2,000 tanks in the northeast United States. Thus, with the new construction alternative, a tank can undergo corrosion control about every 3.3 years as shown below, while the renovation alternative shows that a tank can undergo corrosion control at 5 year intervals. The second alternative is the renovation alternative: modify existing unused space to accommodate the corrosion control function. Expected life is 25 years. The second is the new construction alternative: demolish the old space and build a new, highly efficient, semi-automated corrosion control facility. Expected life is 25 years. Suppose there are 2,000 tanks in the northeast United States. Although both maintenance cycles are acceptable, more frequent corrosion control is preferred because of the cumulative effect of corrosion.

$$\textit{New Construction:} = \frac{2{,}000\,(\textit{Tanks})}{600(\textit{Tanks/year})} = 3.3\ \textit{years/maintenance}$$

$$\textit{Modification:} = \frac{2{,}000\,(\textit{Tanks})}{400\,(\textit{Tanks/year})} = 5\ \textit{years/maintenance}$$

This comparison is made easier by finding an annual BCR (ABCR) for each alternative:

Figure 6–1. New construction and modification comparison example

$$ABCR = \frac{ABOM}{ANB}$$

Where:
ABOM = Annual benefit/output measure
ANB = NPV/Cumulative End-of-Year Discount Rate

Figure 6–2 annual benefit/cost ratio

(7) Table 6–1 contains the data for this example. The table shows that, although the new construction alternative is more expensive, the benefit (output) per equivalent annual dollar spent is 30 percent higher than that for the modification alternative: 1.71/1.32 = 1.30.

(8) No significance should be given to the relation of the annual benefit/cost ratio (ABCR) to the number 1. Unlike the SIR, EPIR, and BCR, the absolute size of the ABCR is not important. This is because of the dimensional quality of the ABCR and the arbitrarily chosen baseline (that is, completed maintenance jobs per year, per $1000). Thus, the only valid comparison is between the two ABCR measures. (The reader should not confuse this situation with that of a non-dimensional SIR, in which unity has vital significance.)

(9) The various BCR methods should be used only when the unit of measure for the benefits and costs of each alternative is the same. If this is not the case, the BCR, like any other measure, will confuse important information and can be misleading.

d. Non-quantifiable output measures. It is not always possible to quantify all beneficial impacts of a project; some benefits such as improved morale, increased retention rates, better troop quarters, and other qualitative benefits are not readily quantifiable, nor does a convenient proxy exist. Any attempt to quantify these benefit streams will result in questionable results and the expenditure of significant resources. The return on such an investment is small and will likely not affect the final decision. However, they should be documented in the EA report (ECONPACK, section Non-monetary considerations) for consideration by the decision makers. These written qualitative benefit descriptions can make a positive contribution to the EA.

Table 6-1
Example annual benefit/output measure

Item	Modification	New Construction
Recurring annual expenses (personnel, O&M, and so forth)	$ 100,000	$ 85,000
NPV of recurring costs	$ 865,462	$ 735,643
Investment (year 1)	$2,000,000	$2,600,000
PV of investment	$1,906,925	$2,479,003
NPV	$2,772,387	$3,214,645
ANB (NPV/Cumulative end-of-year discount rate)	$ 302,629	$ 350,905
ABOM (benefit/output maintenance jobs performed)	400/year	600/year
ABCR (benefit/completed maintenance jobs per year per	1.32	1.71

e. Statements on non-quantifiable benefits (NQB) should follow these guidelines:

(1) Identify all non-quantifiable benefits associated with each alternative and give complete details.

(2) Identify benefits common in kind, but not in extent or degree among alternatives, and explain the differences.

(3) Avoid platitudes. For example: all prospective projects are worthwhile because they support national defense; statements to this effect are not needed.

(4) Negative aspects of an alternative should also be reported and quantified when possible. This information is important to the decision maker and may be a determining factor in selecting an alternative.

Chapter 7
Cost Sensitivity Analysis

7–1. Automation
It is not necessary for the analyst to perform the laborious computations or know the equations necessary to those calculations. The analyst should not attempt to model complex interactions by modeling simultaneous changes in timing and magnitude as interpretation of any results can be very difficult. In most cost sensitivity analyses it is necessary only to vary the two largest cost categories in any given alternative. ECONPACK has an automated feature which performs cost sensitivity analyses. All that is required of the analyst is to select those cost variables which need to be subjected to a cost sensitivity analysis. In light of this automation, the calculations and equations necessary to complete a cost sensitivity analysis will not be presented here.

7–2. Discussion
Once all project data has been collected and the pertinent costs and benefits of each alternative estimated, an analysis of alternatives or life-cycle cost analysis is conducted (steps to performing this analysis are discussed above). The end result of a life-cycle cost analysis is a ranking of alternatives by economic efficiency, NPV, DPP, savings-to-investment ratio, and return on investment. This ranking is not the final step in an economic analysis.

a. With the exception of the status quo alternative most alternatives are conceptual and the values used to conduct the analyses are estimates of actual values occurring at some point in the future. Because of the notional nature of these alternatives there is necessarily a level of variability between the actual future value and the estimate employed. Cost sensitivity analyses are used to account for the level of variability between the true value and the estimated value and evaluate the effect of these uncertainties on the ranking of the alternatives. It provides this extra dimension to an economic analysis. Even if actual cost data from past projects are used, it is assumed that these data points reflect an accurate estimate of these future costs.

b. To test cost sensitivity of the various variables, the concepts and processes described in chapter 3-8 should be used. For each variable and combination of variables that is likely to be volatile enough to change the ranking of alternatives, the degree to which the solution is sensitive to changes must be calculated. It is essential to estimate the likelihood that such a shift in the variable will occur.

c. No single criterion can be used to select which variables are most important and should be included in the cost sensitivity analysis, nor is there any universal criteria which will designate the correct number of variables to include. Each analysis is unique in the number, size, and variability of the variables included in the analysis. When considering which variables to subject to sensitivity analysis, a general rule is the 20 percent rule. If the sum total of the life-cycle costs of a given variable equal or exceed 20 percent of the sum total of the life-cycle costs of an alternative, then it is necessary to subject this variable to sensitivity analysis. Additionally, if in calculating the estimated values of any given variable, it was necessary to make assumptions regarding the magnitude of these expenses or their timing, it is necessary to subject these variables to cost sensitivity analyses.

d. The analyst should employ common sense when deciding which variables, cost or benefit categories, require sensitivity analyses. A given cost or benefit variable should be subjected to a sensitivity analysis whenever significant assumptions were made to produce that cost or benefit. Consider a project which addresses the need for a Physical Fitness Facility in a foreign country. It is possible to either lease or construct this facility. Because the period of analysis for the construction alternative will need to equal the term of the lease; assumptions will have to be made about the long term exchange rate. Given the risk and uncertainty in making an assumption on the average exchange rate between two currencies, the value of the exchange rate should be subjected to a sensitivity analysis.

e. The goal of this analysis is to define the percentage change in exchange rates that would cause a change in the ranking of alternatives. Additionally, if the ranking of alternatives indicates an alternative to be significantly less costly than all other alternatives, the need to perform cost sensitivity analyses is reduced, as small variations in costs of that alternative will have little to no effect on alternative rankings. However, when the range of costs between alternatives is relatively small, small changes in the timing or magnitude of a cost can change the alternative ranking. Paragraph 7–3 discuss the presence of uncertainty in a single alternative and in multiple alternatives.

f. The results of the cost sensitivity analysis is to be reported in ECONPACK section for Results and Recommendations.

7–3. Presence of uncertainty in a single alternative
The simplest case is when uncertainty is present in one or more of the cost categories of a single alternative. The simplest sensitivity analysis would involve re-running the EA using the upper or lower bound value for the cost in question. Instead of utilizing the estimated point value, the analyst would need to describe the amount of variation expected for a given cost

category and then either increase or decrease the estimated value by the amount of expected variation. Figure 7–1 presents the cash flow diagrams for two alternatives which will be subjected to a sensitivity analysis.

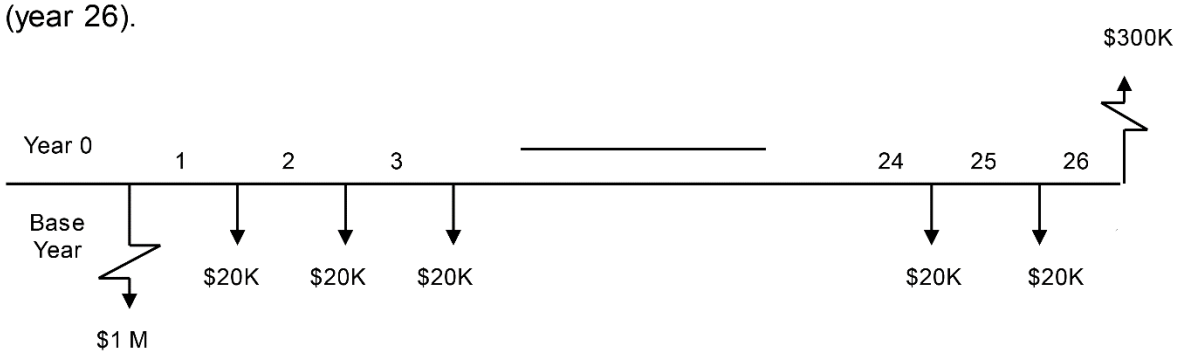
a. Example. Assume there are two viable alternative courses of action for a given project; one involves the renovation of an existing facility and the other involves new construction of a purpose built facility. The economic life of the facility is estimated at 25 years, requiring a 1–year renovation or construction period. The discount rate used is 10 percent (middle of the year discounting convention for all cash flows except residual value). The base year to which all costs are discounted is year one. Table 7–1 shows the data, figure 7–1 shows the cash flow diagrams, and NPVs for the new construction and renovation alternatives. The life-cycle cost analysis suggests that the renovation alternative is the most economically efficient alternative as its NPV is $ 73,417.29 less than that of new construction.

Table 7–1
Net present value data for sensitivity analysis example

New Construction Alternative				Renovation Alternative			
Year	Discount Rate	Cash Flow	Discounted Cash Flow	Year	Discount Rate	Cash Flow	Discounted Cash Flow
0.5	0.95346	$1,000,000	$953,463	0.5	0.95346	$750,000	$715,097
1.5	0.86678	$20,000	$17,336	1.5	0.86678	$30,000	$26,004
2.5	0.78799	$20,000	$15,760	2.5	0.78799	$30,000	$23,640
3.5	0.71635	$20,000	$14,327	3.5	0.71635	$30,000	$21,491
4.5	0.65123	$20,000	$13,025	4.5	0.65123	$30,000	$19,537
5.5	0.59203	$20,000	$11,841	5.5	0.59203	$30,000	$17,761
6.5	0.53820	$20,000	$10,764	6.5	0.53820	$30,000	$16,146
7.5	0.48928	$20,000	$9,786	7.5	0.48928	$30,000	$14,678
8.5	0.44480	$20,000	$8,896	8.5	0.44480	$100,000	$44,480
9.5	0.40436	$20,000	$8,087	9.5	0.40436	$30,000	$12,131
10.5	0.36760	$20,000	$7,352	10.5	0.36760	$30,000	$11,028
11.5	0.33418	$20,000	$6,684	11.5	0.33418	$30,000	$10,025
12.5	0.30380	$20,000	$6,076	12.5	0.30380	$30,000	$9,114
13.5	0.27618	$20,000	$5,524	13.5	0.27618	$110,000	$30,380
14.5	0.25108	$20,000	$5,022	14.5	0.25108	$30,000	$7,532
15.5	0.22825	$20,000	$4,565	15.5	0.22825	$30,000	$6,848
16.5	0.20750	$20,000	$4,150	16.5	0.20750	$30,000	$6,225
17.5	0.18864	$20,000	$3,773	17.5	0.18864	$30,000	$5,659
18.5	0.17149	$20,000	$3,430	18.5	0.17149	$30,000	$5,145
19.5	0.15590	$20,000	$3,118	19.5	0.15590	$30,000	$4,677
20.5	0.14173	$20,000	$2,835	20.5	0.14173	$30,000	$4,252
21.5	0.12884	$20,000	$2,577	21.5	0.12884	$30,000	$3,865
22.5	0.11713	$20,000	$2,343	22.5	0.11713	$30,000	$3,514
23.5	0.10648	$20,000	$2,130	23.5	0.10648	$30,000	$3,194
24.5	0.09680	$20,000	$1,936	24.5	0.09680	$30,000	$2,904
25.5	0.08800	$20,000	$1,760	25.5	0.08800	$30,000	$2,640
26	0.08391	$(300,000)	$(25,172)	26	0.08391	0	0
		Total	$1,101,383.31			Total	$1,027,966.03

New Construction

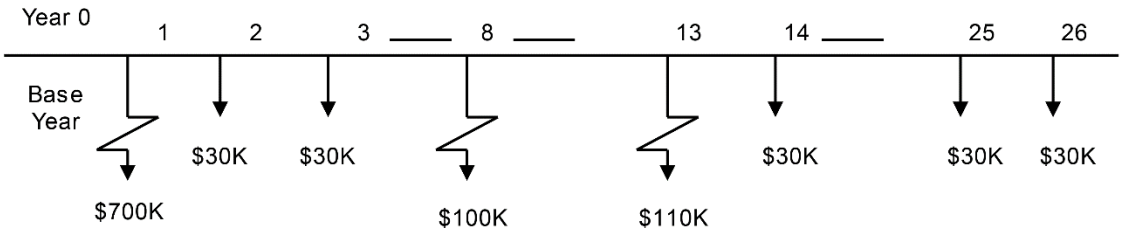
Initial cost is $1,000,000, annual O&M cost is $20,000, and residual value is $300,000 (year 26).



$$NPV_{NEW} = \$1,000,000(0.953) + \$20,000\ (8.654)^* - \$300,000\ (0.084)^*$$
$$= \$953,463 + \$173,092 - \$25,172$$
$$= \$1,101,383.31$$

Renovation

Initial cost is $750,000, annual O&M cost is $30,000, air-conditioner replacement will cost $70,000 in year 8, and roof replacement will cost $80,000 in year 13.



$$NPV_{REN} = \$750,000(0.953) + \$30,000\ (8.654)^*$$
$$+ \$70,000\ (0.444)^* + \$80,000\ (0.276)^*$$
$$= \$715,097 + \$259,639 + \$31,136 + \$22,095$$
$$= \$1,027,966.12$$

*Discount factors within equations are rounded to the thousandths place but in calculation are carried out to the eight places.

Figure 7–1. Cash-flow diagram for uncertainty example

b. Suppose that there is a great deal of uncertainty concerning the estimated O&M costs ($30,000 O&M) of the renovation alternative; professional opinion indicates that the actual future O&M costs could be as much as 50 percent higher

than the estimated value. Increasing the assumed O&M value from $30,000 to $45,000 increases the total NPV of the renovation alternative to $1,157,785.30, an increase of $129,819.27 over the original NPV. This increase in assumed O&M costs changes the relative ranking of the alternatives. The NPV of the renovation alternative, assuming $45,000 in annual O&M costs, exceeds the NPV of the new construction alternative by $56,401.99. The results of this sensitivity analysis suggest that the ranking of alternatives and the ultimate choice of the preferred alternative, the economically efficient alternative, is sensitive to changes in O&M costs. This is the essence of a sensitivity analysis. Table 7–2 shows the calculation steps for this analysis.

Table 7–2
Operation and maintenance data deviation for sensitivity analysis example

New Construction Alternative				Renovation Alternative			
Year	Discount Rate	Cash Flow	Discounted Cash Flow	Year	Discount Rate	Cash Flow	Discounted Cash Flow
0.5	0.95346	$1,000,000	$953,463	0.5	0.95346	$750,000	$715,097
1.5	0.86678	$20,000	$17,336	1.5	0.86678	$45,000	$39,005
2.5	0.78799	$20,000	$15,760	2.5	0.78799	$45,000	$35,459
3.5	0.71635	$20,000	$14,327	3.5	0.71635	$45,000	$32,236
4.5	0.65123	$20,000	$13,025	4.5	0.65123	$45,000	$29,305
5.5	0.59203	$20,000	$11,841	5.5	0.59203	$45,000	$26,641
6.5	0.53820	$20,000	$10,764	6.5	0.53820	$45,000	$24,219
7.5	0.48928	$20,000	$9,786	7.5	0.48928	$45,000	$22,017
8.5	0.44480	$20,000	$8,896	8.5	0.44480	$115,000	$51,152
9.5	0.40436	$20,000	$8,087	9.5	0.40436	$45,000	$18,196
10.5	0.36760	$20,000	$7,352	10.5	0.36760	$45,000	$16,542
11.5	0.33418	$20,000	$6,684	11.5	0.33418	$45,000	$15,038
12.5	0.30380	$20,000	$6,076	12.5	0.30380	$45,000	$13,671
13.5	0.27618	$20,000	$5,524	13.5	0.27618	$125,000	$34,523
14.5	0.25108	$20,000	$5,022	14.5	0.25108	$45,000	$11,298
15.5	0.22825	$20,000	$4,565	15.5	0.22825	$45,000	$10,271
16.5	0.20750	$20,000	$4,150	16.5	0.20750	$45,000	$9,338
17.5	0.18864	$20,000	$3,773	17.5	0.18864	$45,000	$8,489
18.5	0.17149	$20,000	$3,430	18.5	0.17149	$45,000	$7,717
19.5	0.15590	$20,000	$3,118	19.5	0.15590	$45,000	$7,015
20.5	0.14173	$20,000	$2,835	20.5	0.14173	$45,000	$6,378
21.5	0.12884	$20,000	$2,577	21.5	0.12884	$45,000	$5,798
22.5	0.11713	$20,000	$2,343	22.5	0.11713	$45,000	$5,271
23.5	0.10648	$20,000	$2,130	23.5	0.10648	$45,000	$4,792
24.5	0.09680	$20,000	$1,936	24.5	0.09680	$45,000	$4,356
25.5	0.08800	$20,000	$1,760	25.5	0.08800	$45,000	$3,960
26	0.08391	$(300,000)	$(25,172)	26	0.08391	$-	$-
		Total	$1,101,383.31			Total	$1,157,785.30

c. Alternatively, if we wish to identify the percentage deviation at which the ranking of the alternatives changes we can calculate that percentage. Figure 7–2 shows a means to calculate this percentage drawing on data from Table 7–1 we can construct our equations. If we break the O&M cost variable out from all the other costs we can formulate the renovation equation by which we can cause the cost to deviate. By solving for "x" in the equation below we find that if the O&M costs of the renovation alternative increase by 28.27 percent the cost of the renovation alternative equals the cost of the new construction alternative.

$$NPV_{REN} = \$768{,}327.49 + \$259{,}638.54(x)$$

$$NPV_{CON} = \$1{,}101{,}383.31$$

Where x = the rate of change in the O&M cost

$$1 - (\$768{,}327.49 + \$259{,}638.54(x) = \$1{,}101{,}383.31$$

or

$$1 - \frac{(\$1{,}101{,}383.31 - \$768{,}327.49)}{\$259{,}638.54} = x$$

$$1 - 1.282767 = 28.27\%$$

Figure 7–2. Net present value simplified–renovation and new construction

d. A graphical representation of these two equations are given in figure 7–3. The sum total of the renovation cost, air conditioner replacement cost, and roof replacement cost act as the intercept while the O&M cost represents the slope of the line.

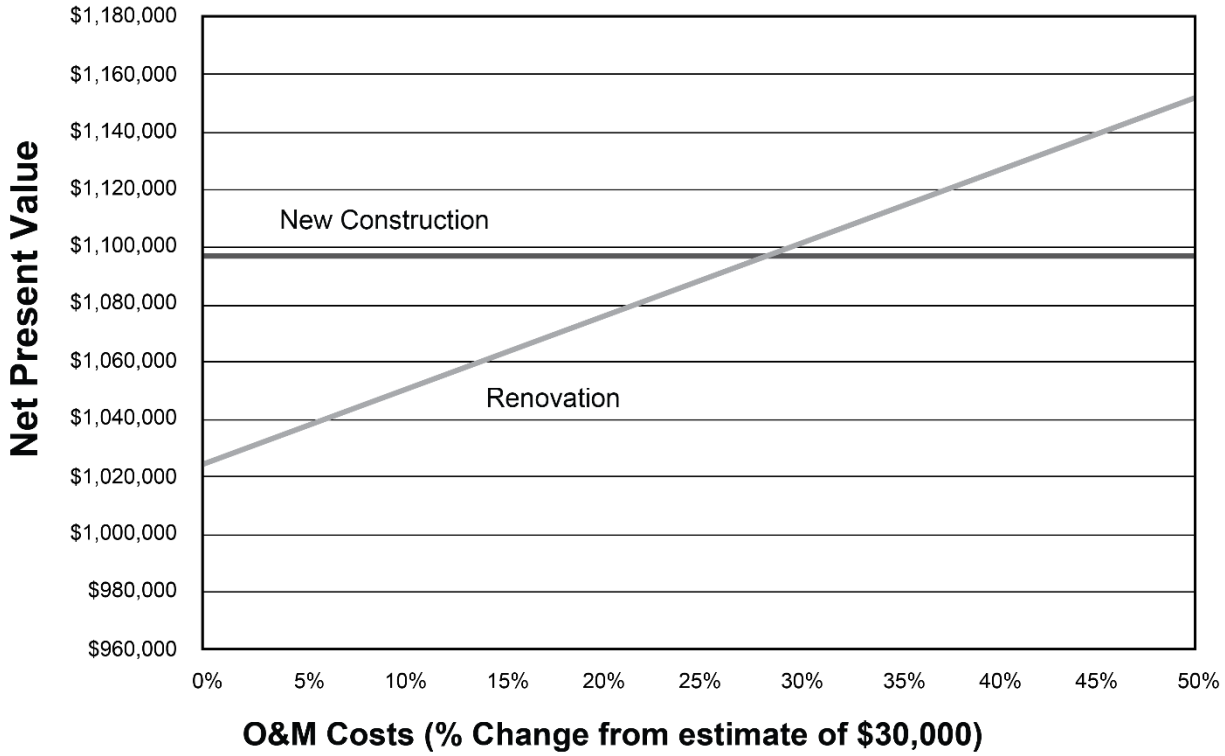


Figure 7–3. Graph of net present value simplified–renovation and new construction

e. The preceding conclusions are based on the assumption that only the O&M costs of the renovation alternative are variable; all other costs remain constant.

7–4. Uncertain cost(s) in two alternatives

a. The more complex situation is the one in which more than one of the estimated costs of an alternative or of several alternatives contain some level of uncertainty. Figure 7–4 depicts both the one-variable uncertainty possibility described above and the more complex situation described in this section.

b. In the simpler of the two cases, where only one alternative's costs contain uncertainty, the NPV of the alternative containing the uncertain costs will either increase or decrease, while the NPV of the other alternative will not change. There is also the more complex case where the sensitivity analysis includes uncertainty in one or more alternatives which result in a change in ranking. In these instances, the NPV of one alternative can increase while that of the other decreases, or both NPVs may increase or decrease at once. In each of the three cases shown, there is a reversal of ranking for the two alternatives.

c. The solution to the complex situation is actually very simple. The NPV of each alternative is expressed as a function of the uncertain costs and the NPVs are set equal to each other. The result is an equation in terms of the percentage change in the costs of each alternative.

d. ECONPACK has a cost sensitivity analysis feature that calculates all possible values for an alternative given a range of uncertainties specified by the user. If the ranking of an alternative is affected for which an indication of ranking reversal is included.

e. Results are reported in ECONPACK in the section "Results and Recommendations."

7–5. Sensitivity analysis for housing economic analyses

For housing economic analyses, it is not useful to make the technical statistical distinction between risk and uncertainty. Housing managers are faced with the difficulty of evaluating assumptions with a degree of uncertainty. These uncertainties must be analyzed in two broad areas.

a. What is the risk of an assumption not holding true?

b. Given that the future may be different from the assumptions, what is the range of possibilities that could occur? How will these possibilities affect the program objectives?

c. To estimate the risk of an assumption, one must consider reasons for the uncertainty. These reasons may be either internal or external.

(1) The internal risks of a project are produced by the project itself. An increase in the size or the complexity an increase in the risk factor. Also, uncertainty is proportional to the number of future years involved.

(2) External risks are those that could occur independently of the project itself. For example, the effectiveness of a well–run leasing project in a foreign country may be reduced by sharp currency fluctuations, or a new construction project may be halted by a strike. Therefore, to find the uncertainty level of an assumption, one must recognize the possibility of both internal and external risks.

d. For the housing manager, the effects of these risks on assumptions will be shown by cost changes. In cost analysis, a distinction should be made between requirements uncertainty and cost estimating uncertainty. Requirements uncertainty represents variations in the physical elements of the alternative, while cost estimating uncertainty relates to changes in the final cost of the alternatives. Examples of requirements uncertainty are future post staffing level, community housing availability, cost of community housing that influences the number of families and unaccompanied personnel voluntarily living off post, and the quantity of utilities required. Examples of cost estimating uncertainty are the unforeseeable shifting of the cost of utilities, construction, transportation, equipment rental or lease, and foreign exchange rates.

e. Since assumptions are necessary when doing an economic analysis and since the levels of many inputs are seldom known with certainty, areas of uncertainty could affect the study results. Thus, the study should address uncertainty and treat it explicitly to expose and reduce, if possible, the unknowns that could affect the decision. Sensitivity analysis deals with uncertainty by changing the values of key variables over feasible ranges to identify the variables that drive the results and to examine the stability of the ranking of alternatives. Other statistical and mathematical techniques may also be used to show or reduce the possibility of altering the ranking of alternatives. The sensitivity analysis also aids in identifying the most cost–effective alternative under conditions of uncertainty.

f. The housing manager's estimate will be an assessment of the end cost expected for a project. As such, the estimate should be relatively stable over long periods of time and not change with small increases to the approved program, funding changes, or financial fluctuations. To the extent possible, schedules and funding should be structured to handle program uncertainties and unforeseen problems. Special degrees of risk or uncertainty related with a project may be pointed out quantitatively in an analysis. This data may be used for program review purposes. Sometimes, probability estimates can be developed by testing the sensitivity of key variables on estimated costs and performance. The narrative must show the probability that each of the possible cost or output estimates may be realized.

g. Estimates must be stated in terms of performance thresholds, goals, or ranges. Project estimates will include the limits within which program cost and technical performance are expected to fall.

h. A sensitivity analysis of decision will identify critical elements. A sensitivity analysis measures the degree of change in one or more elements that will reorder a ranking of alternatives.

i. When conducting an economic analysis, the stated cost estimates depict the analyst's best judgment of the way in which expected future cash flows will occur. Future costs, economic life, and other data are estimated based on reasonable expectations. They are rarely known with certainty. The degree of uncertainty generally increases with the time interval between the estimate and the occurrence. In addition to recognizing uncertainty during the estimating process, it is prudent to examine the degree to which each of the variables may be higher or lower than the best estimate.

j. If some cost elements were sufficiently different, the ranking of alternatives would be different. On the other hand, radical changes could be made to other elements without changing the decision. For example, if one element can be varied over a wide range of values without affecting the decision, the decision is said to be insensitive to uncertainties regarding that element. However, if a small change in the estimate of one element will alter the decision, the decision is said to be very sensitive to changes in the estimate of the element.

k. As with an economic analysis, the watchword in sensitivity analysis is common sense. If the preference ranking of alternatives sets up one option as markedly superior to the rest, the analyst should not be overly concerned about the sensitivity of this choice to nominal variations in the values of input parameters. When an economic choice is not clear–cut, further investigation is needed. Sensitivity analysis should be applied as an iterative process to refine the analysis. Rather than developing a formal theory, the remainder of this section describes basic techniques most commonly applied in sensitivity analysis.

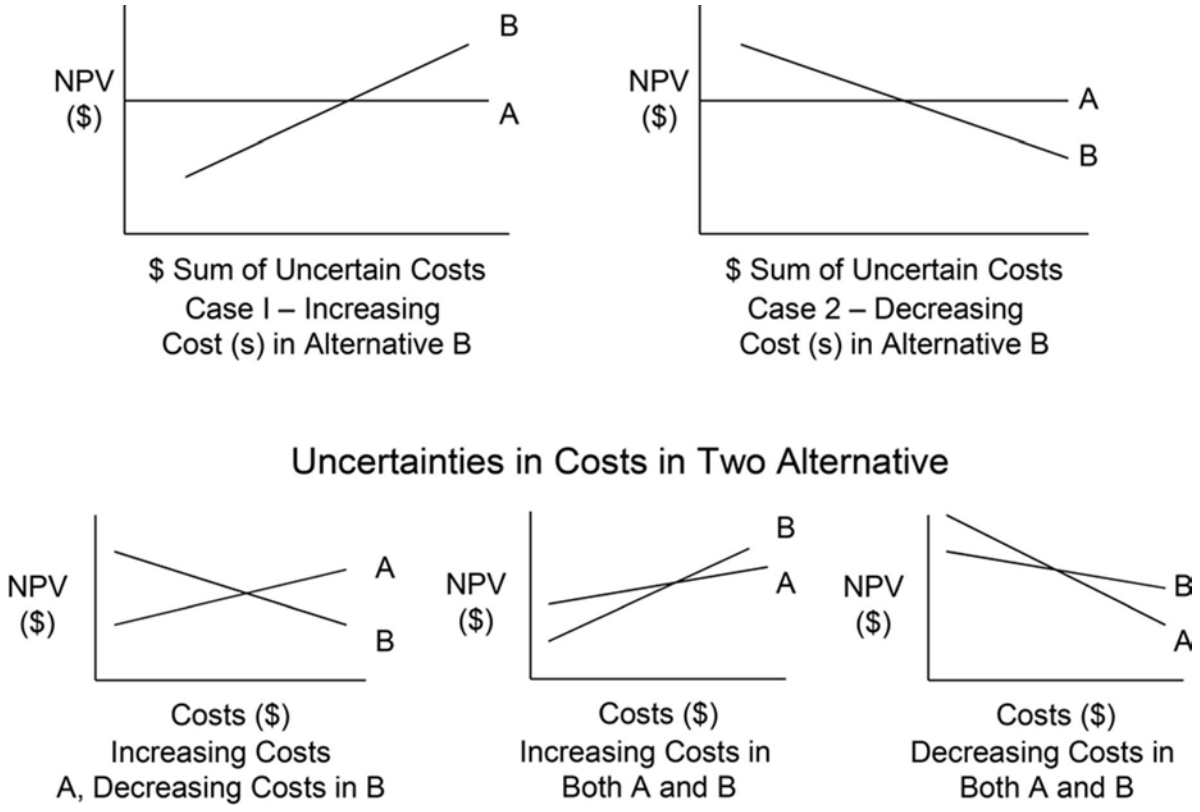


Figure 7–4. Graphs showing relationships between net present values of alternatives with uncertainties

Chapter 8
Centralized review process

8–1. Review process summary

a. Once a project has been included into the Fiscal Year Defense Plan (FYDP), the MILCON EA Reviewer will proceed with the review process.

b. Download the project's DD Form 1391 and will review the DD Form 1391's tabs A (Additional Paragraph statement) and D for compliance to this DA PAM.

c. If the analysis complies with all tenants of this DA PAM, the analysis will be certified as compliant in the EA Certification function in the PAX System.

d. The Lead MILCON Economist or that person's designated representative must certify a DD Form 1391's tab D prior to that project being approved by the Military Construction Integrated Programming Team, in accordance with the Facility Investment Guidance.

8–2. Rejection of an economic analysis

a. If the analysis does not comply with the tenants of this DA PAM or if more information is required, the analysis will be returned to the garrison for correction.

b. If a project gets reevaluated and is pushed back a year or moved forward in the FYDP, the EA will be reviewed again to ensure the EA is still reflecting the information (scope and cost) provided on the DD Form1391 tab A.

Appendix A

References

Section I

Required Publications

This section contains no entries.

Section II

Related Publications

A related publication is a source of additional information. The user does not have to read the publication to understand this regulation.

AR 25–30
Army Publishing Program

AR 420–1
Army Facilities Management

DA PAM 415–28
Guide to Army Real Property Category Codes

DFAS-IN 37–1
Finance and Accounting

DODM 4165.63
DOD Housing Management (Available at http://www.esd.whs.mil/dd/.)

DOD 7000.14–R, Volume 2B
DOD Financial Management Regulation Volume 2B: "Budget Formulation and Presentation (Chapters 4–19)" (Available at http://comptroller.defense.gov/.)

DODI 4165.69
Realignment of DOD Sites Overseas (Available at http://www.esd.whs.mil/.)

DODI 7041.3
Economic Analysis for Decision-Making (Available at http://www.esd.whs.mil/.)

FAR 45.3
Authorizing the Use and Rental of Government Property (Available at http://farsite.hill.af.mil.)

FAR 45.302
Contracts with Foreign Governments or International Organizations (Available at http://farsite.hill.af.mil.)

OMB Circular A–94
Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs (Available at https://www.whitehouse.gov/omb/information-for-agencies/circulars.)

Public Law 115–19
National Defense Authorization Act FY18 (Available at https://www.gpo.gov/fdsys/.)

UFC 1–200–01
DoD Building Code (General Building Requirements) Section III (Available at https://www.wbdg.org/.)

UFC 4–010–01
DOD Minimum Antiterrorism Standards for Buildings, With change 1 (Available at https://www.wbdg.org/.)

10 USC 2805
Unspecified minor construction (Available at http://uscode.house.gov/.)

Section III

Prescribed Forms

This section contains no entries.

Section IV

Referenced Forms

Except where otherwise indicated below, the following DA Forms are available on the APD website (http://www.apd.army.mil); DD Forms are available on the OSD website (http://www.dtic.mil/whs/directives/info-mgt/forms/formsprogram.htm).

DA Form 2028
Recommended Changes to Publications and Blank Forms

DD Form 1391
FY, Military Construction Project Data

Appendix B

Reporting the Results of the Housing Economic Analysis

B–1. General character of the report

a. The report that transmits the results of an economic analysis should be concise in summary. Yet, it should have enough detailed sections to document the credibility of the analytical techniques and processes. It must also document sources of information and estimates thoroughly. This will enable the reviewers at the Army Corps of Engineers, Army Housing Management Division, and OSD to determine the suitability of the source and the credibility of the information. Also, the report must present all of this information and the conclusions indicated by the analysis in a clear, effective manner. The report must be organized to reduce the time a reviewer needs to understand the report. It must also lessen the time an informed reviewer needs to evaluate the merit of the proposed solution. This chapter is directed toward accomplishing these ends.

b. On the basis of previous documentation validating similar projects, an economic analysis report may combine the data for several communities. This is acceptable only where an economic analysis has been prepared for each community separately within the last 5 years. Such a report must name each community, describe areas of similarity, describe areas of individual differences, and identify previous documentation that validated the similarity of the communities. It is acceptable to group the data for several similar communities. It is not acceptable to group communities where the cost characteristics are dissimilar. It is not acceptable to group communities before demonstrating their similarity.

B–2. Outline of the report

a. The preferred sequence and content of the economic analysis report is in paragraphs B–2*b* and *c*. Summary and detail are the keys to effective preparation and presentation of the results of an economic analysis.

b. Documenting the economic analysis is important because much of the effort that goes into collecting and compiling data will be lost if it is not presented clearly and effectively. Tables, charts, graphs, mathematical models, and other visual aids can often be designed to replace a lengthy narrative explanation. They can also stress the most important facts and relationships. This material should be included when it will help the presentation or the result of the analysis. The sequence of material in the report is not the same as the sequence of performance or preparation of the data. Better communication with reviewers and decision makers is achieved by the sequence presented in paragraph B–2*c*.

c. If possible, each economic analysis should include the following essential elements in the sequence indicated:

(1) *Letter of transmittal.* This letter should include only a statement of the decision requested and notice of transmittal of the justification. More information would be counterproductive.

(2) *Executive summary.* This summary is the capstone of the economic analysis. Its careful preparation and presentation can determine whether the end result of the economic analysis will be understood and accepted by those making the decision. The purpose of doing an economic analysis is to find the most efficient and effective alternative for achieving the objective involving the allocation of scarce resources. The objective of the executive summary is to communicate the results determined by the economic analysis to those with decision authority. Therefore, the executive summary should include only the end result information that identifies the following elements in sequence:

(a) The decision objective. The objective of the economic analysis should clearly state the decision to be made. Include directly related mission objectives and requirements. Those with decision authority must be able to understand immediately and clearly the dimensions of the problem that required the economic analysis. The actual wording of the objective is critical, as it should reflect a totally unbiased point of view on methods to meet the objective.

(b) Recommended course of action. State the preferred alternative clearly and the reasons for its selection. If the recommended course of action is not the lowest present value cost, as determined by the economic analysis, this section of the executive summary should explain in detail the justification for not selecting the least–cost alternative. Qualitative and quantitative data showing such information as the availability of community housing, effect on mission, combat readiness, morale, turnover, and Family stability should be cited to support an alternative other than the least–cost alternative. In short, when recommending any course of action other than the least cost, extensive, clear, and compelling justification should be developed and presented if a favorable decision is to be obtained.

(c) Major assumptions. The process of economic analysis deals with future expenditures and involves elements of uncertainty. A complete factual picture of an alternative under consideration may be impossible to construct. Also, certain assumptions may be necessary to proceed with the analysis. When this is the case, all assumptions used in the analysis should be briefly summarized. A more elaborate discussion of the constraints, assumed or imposed, along with the underlying rationale should be presented in the detailed statement of assumptions (see para B–2*c*(7)).

(d) Alternative courses of action. This section of the executive summary should state and briefly describe each alternative considered and not considered in the economic analysis. Extensive justification of the alternatives considered and not considered should be presented in the detailed identification of alternatives (see para B–2*c*(8)).

(e) Economic analysis results. The results of the economic analysis should be concisely outlined. The presentation should include a present value summary comparison of the alternatives analyzed. It should also include a brief summary discussion of benefits and costs of each of the considered alternatives.

(f) Sensitivity factors. The impact that sensitivity analysis had on the economic analysis results should be briefly summarized. The discussion of sensitivity factors should identify which cost elements and kinds for each alternative affected the results of the economic analysis. Extensive discussion of the sensitivity analysis should be included in the detailed statement of sensitivity analysis (see para B–2*c*(6)).

(3) *Preparers of the economic analysis*. The names and phone numbers of the individuals preparing the analysis should be listed. This helps a reviewer or decision maker to have a point of contact if a question arises. If the analysis was prepared by a contractor, the name of the company, its address, and phone number should also be listed.

(4) *Approval authority for the economic analysis*. The name, rank, title, and organization of the installation approval authority should be given.

(5) *Detailed summary of economic analysis including detailed cost buildup and discounting analysis*. The detailed results of the economic analysis should be specified. This section should begin with a matrix for each alternative, listing FYs down the left column. For each of these years, each major cost kind is entered in its own column; they should be totaled and discounted. This section should also present NPV of the alternative, present value of any residual values, and average annual discounted cost. Congress and OSD have expressed a strong preference to having data presented in these formats. Also, these formats should be used whenever possible to present such items as the cost buildup, discounting analysis requirements, and comparison of alternatives based on different inflation, use, or other characteristics.

(6) *Detailed statement of sensitivity analysis.*

(a) Sensitivity of the economic analysis. The sensitivity of the economic analysis to variations of the cost kinds and cost elements that contribute the most to the total cost must be evaluated. Also, assumptions and characteristics that contain significant risks are identified and the sensitivity of the economic analysis evaluated. How likely it is that the estimating inaccuracies will cause a shift of the rankings should be indicated. (See fig B–1 for calculating sensitivity.)

(b) Combined analysis. An economic analysis may combine data for two or more communities that are relatively similar. Such a combined analysis must include special consideration of the sensitivity factors. It must state the degree to which the data for each community may be sensitive. It should also identify the unique characteristics of each community, and fully discuss the extent to which these characteristics affect the decision.

(7) *Detailed statement of assumptions.* A comprehensive statement of the assumptions on which the economic analysis is based must be included. These assumptions relate to many portions of the analysis and impact on various calculations throughout the analysis. They must be stated concisely, clearly, and in a manner that relates them to the cost elements, cost kinds, or other elements of the analysis. A list of assumptions may be needed for each alternative.

(8) *Detailed identification of alternatives*. All feasible alternatives of meeting Army housing objectives must be specified and defined in detail. All reasonable and viable alternatives should be considered, or the value of the analysis will be seriously undermined. Considering all alternatives provides useful information about impossible alternatives. Each alternative should be described in enough detail to inform reviewers and decision makers of its characteristics. Descriptions that involve quality evaluations on the desirability of one or more housing alternatives are explained in paragraph B–2*c*(11).

(9) *Cost data.* Identification of cost elements, cost kinds, and basic parametric information required for cost calculations. A display that appears early in this section would contain a list of all cost elements and kinds related to the alternatives. This matrix should list the costs that apply to each alternative. (See table 5–1 for matrix examples.) It should include identical costs for each alternative, and then highlight them as wash costs that will not be included in the rest of the analysis because they do not affect the decision. Identification of the source should be included for each element of cost data. Also, a calculation of annual constant dollar costs and construction costs to be included in the buildup should be made. Nonmonetary factors must be excluded from this section; they belong with nonmonetary factors (see para B–2*c*(11)).

(10) *Source documents.* A copy of the latest housing market analysis and other documents that are believed to be related should be included, showing the date these documents were prepared. Also, a segmented housing market analysis and other documents that are believed to be relevant should be included. (See AR 420–1 for additional information.)

(11) *Nonmonetary factors.* All of the nonmonetary discussion, documentation, and declarations of preferences and conditions that should influence the decision are included here. These should be specific, quantitative, and comprehensive in this area. General statements will be of little help, and preferences should not be shown. The primary objective of an economic analysis is to determine the best and least costly course of action, not to justify the preferred course of action. Each element of this section should be related to the objectives of the analysis and to the alternatives being evaluated.

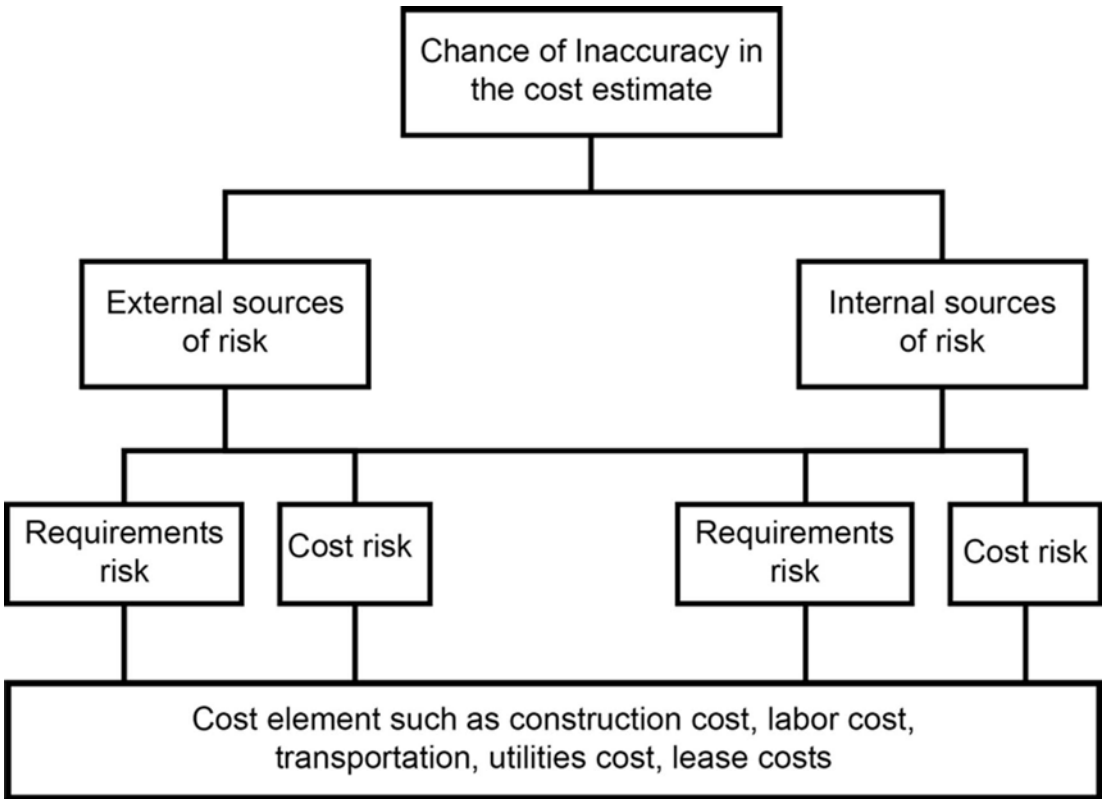


Figure B–1. Project review process-conceptualization of risk and uncertainty

Glossary

Section I

Abbreviations

ABCR
annual benefit/cost ratio

ABOM
annual benefit/output measure

AFC
area cost factor

AFHC
Army Family Housing Construction

AMC
U.S. Army Material Command

ANB
net present value divided by cumulative end-of-year discount rate

AR
Army regulation

AT/FP
Anti-terrorism/Force Protection

BAH
basic allowance for housing

BCR
benefit/cost ratio

BRAC
base realignment and closure

CFL
compact fluorescent light

COCO
contractor-owned, contractor-operated

CONUS
continental United States

DA
Department of the Army

DAIM–ISH
Department of the Army Installation Services Housing

DD
Department of Defense

DES
Department of Emergency Services

DFAC
dining facility

DOD
Department of Defense

DODD
Department of Defense Directive

DOE
Department of Energy

DOL
Directorate of Logistics

DPP
discounted payback period

DU
dwelling unit

EA
economic analysis

ECONPACK
economic analysis package

EPIR
efficiency/productivity increase ratio

EUAC
equivalent uniform annual cost

FAR
Federal Acquisition Regulation

FMR
Federal Management Regulations

FY
fiscal year

FYDP
fiscal year defense plan

GOCO
Government-owned, contractor–operated

GOGO
Government-owned, Government-operated

GS
general schedule

GSA
general services administration

HMA
Housing Market Analysis

HNFA
host nation funded construction agreements

HQ
Headquarters

HQDA
Headquarters, Department of the Army

HRS
housing referral services

HVAC
heating, ventilation and air conditioning

IMCOM
U.S. Army Installation Management Command

LED
light emitting diode

LHC
land holding command

MCA
military construction Army

MCAR
military construction Army Reserve

MCNG
military construction National Guard

MILCON
military construction

NATO
north atlantic treaty organization

NGB
National Guard Bureau

NPV
net present value

O&M
operation and maintenance

OACSIM
Office of the Assistant Chief of Staff, Installation Management

OCAR
Office of the Chief, Army Reserve

OCONUS
outside continental United States

OHA
overseas housing allowance

OMB
Office of Management and Budget

OSD
Office of the Secretary of Defense

PAM
pamphlet

PAX
Programming, Administration and Execution System

PC
planning charrette

PIK
payment in kind

POD
U.S. Army Division, Pacific Ocean

PV
present value

PX
post exchange

RDT&E
research, development, tests and evaluation

ROI
return on investment

SIR
savings/investment ratio

SOFA
status of forces agreement

TLA
temporary lodging allowance

UFC
unified facility code

UMMCA
unspecified minor, military construction army

USACE
U.S. Army Corps of Engineers

USAISEC
U.S. Army Information Systems Engineering Command

Section II

Terms

Acquisition cost
The amount paid to acquire an asset.

Actual cost
The amount based on cost incurred as distinguished from estimated costs. This includes standard cost properly adjusted for applicable variance.

Allocate
To assign an item of cost or a group of items of cost to one or more cost objectives. This term includes both direct assignment of cost and the reassignment of a share from an indirect cost pool.

Allocation base
The denominator in the fraction used to develop an overhead rate. It is either the total of some element of expense (or group thereof) or a quantity measurement that is common to all items or activities to which the indirect costs are to be allocated.

Alternative
A course of action, means, or methods by which an objective may be achieved.

Alternative ranking
The end result of an economic analysis; the rating of options from lowest to highest in terms of dollar value or another indicator.

Amortization
The gradual reduction of the balance in an account according to a specified schedule of time and amounts. This is usually used to liquidate a debt including interest.

Analysis
A systematic approach to problem solving. Complex problems are made simpler by separating them into more understandable elements. Involves identification of purposes and facts, statements of assumptions, and derivation of conclusions. Analyses normally use quantitative methods and are done to support decision-making processes.

Appropriation
The most common form of budget authority. Allows Federal agencies to incur obligations and make expenditures for specified purposes and in specified amounts as authorized by the U.S. Congress.

Assets
Real and personal property and other items of monetary value.

Assumption
An explicit statement describing present or future circumstances that may affect the outcome of an analysis.

Base year
The reference year for all present value calculations (costs are converted to present value amounts as of the beginning of the base year).

Basic labor rate
For Wage Board employees, the hourly rate to be applied to all hours worked and to all hours of annual leave earned, and sick, holiday and other leave taken. The General Schedule (GS) basic rate is the published annual rate of pay for the particular GS grade and step level.

Benefit
Outputs or effectiveness expected to be received or achieved over time as a result of implementing an alternative. These can be quantifiable in terms of dollar value or some other measure of productivity, or nonquantifiable as in the case of intangible effects such as increased morale.

Benefit cost analysis
An analytical approach to solving problems of choice. It requires the definition of objectives and identification of alternative ways of achieving each objective of that alternative that yields the required level of benefits at the lowest cost. This same analytical process is often referred to as cost–effectiveness analysis when the benefits or outputs of the alternatives cannot be quantified in dollars. (In either form of analysis, qualitative and quantitative factors, foreseeable secondary or side effects, and noneconomic benefits are considered.)

Benefit cost ratio
An economic indicator of efficiency defined as the ratio of the value of benefits to costs. When benefits are expressed in dollar terms, both the benefit and cost streams are discounted to reflect the present value of future costs and benefit.

Bill of material
A detailed listing of the material requirements for providing a service or product.

Budget year
Precedes the program year in which funds are made available for construction and follows the design year. The year in which the Army defends the MILCON Program before OSD, OMB, and Congress, and the year final design is to be substantially completed.

Build–to–lease
A program for providing Government facilities through private sector development. The Government contracts with a private developer to have facilities built, with a guarantee that the Government will lease the facilities for a period of time.

Capital
Assets of a permanent character with continuing value. Examples are land, buildings, and other facilities including equipment.

Capitalized cost
The cost to acquire, install, and modify a tangible capital asset that has been added to an asset account.

Cartage
Transportation from a freight terminal to the point of use or consumption.

Command operating budget
An annual document that constitutes a command's recommendation for the allocation of resources during budget formulation.

Commercial or industrial–type functions
Those functions, which in their execution, provide the same type of products or services that could be obtained by contract from private commercial or industrial sources.

Commercially financed facilities
Facilities financed by the private sector as an alternative funding method for DOD to procure certain types of service facilities. Different types of construction programs (MILCON, AFHC, and Energy) derive Authority to pursue commercially financed facilities from separate laws.

Compound interest
Interest, which is computed on both the original principal and its accrued interest.

Constant year dollars
Monetary amounts always connected with a base year and showing the dollar purchasing power for that year. An estimate is said to be in constant dollars if costs for all work, whether prior, current or future, are adjusted so that they show the level of prices of the base year. When cost estimates are stated in constant dollars, the implicit condition is that the purchasing power of the dollar has remained unchanged over the time for the project being costed.

Contract administration costs
The costs incurred by the Government in assuring that a contract is faithfully executed by the Government and the contractor.

Cost
A resource input to a project, program, or activity expressed in dollar terms.

Cost analysis
Determines the magnitude, timing and uncertainties of prices for alternatives. A critical part of economic analysis, it translates resource requirements into estimated dollar costs.

Cost and operational effectiveness analysis
A documented investigation of the following:
a. Comparative effectiveness of alternative means of meeting a requirement for eliminating or reducing a force or mission defect.
b. The validity of the requirement in a scenario which has the approval of Major Army Command HQ and HQ, Department of the Army.
c. The cost of developing, producing, issuing, and sustaining each alternative in a military environment for a time preceding the combat application.

Cost avoidance
Future planned or budgeted costs of the current course of action or status quo alternative that would not be incurred if another course of action were selected.

Cost/benefit analysis
Technique for assessing the range of costs and benefits associated with a given alternative, usually to determine feasibility. Costs are normally in monetary terms, but benefits need not be.

Cost comparison (comparative cost analysis)
An accurate finding of whether it is more economical to acquire the needed products or services from the private sector or from an existing or proposed Government commercial or industrial–type activity.

Cost kind
A group of costs composed of a number of expense item that all contribute to accomplishment of the same function. Several cost kinds, or functions, contribute to accomplishment of an alternative.

Cost objective
A function, organizational subdivision, contract, or other work unit for which cost data are desired and for which provision is made to gather and measure the cost of such items as processes, products, jobs, and capitalized projects.

Cost of capital
An imputed charge on the Government's investment in all housing facilities and other assets needed for the work center to manufacture products or provide services.

Cost, direct
(See direct Costcost.)

Cost–beneficial alternative
The alternative that—
a. Maximizes benefits when costs for each alternative are equal (the most effective alternative).

b. Minimizes costs when benefits are equal for each alternative (the most efficient alternative).
c. Maximizes benefit–cost ratio when costs and benefits are unequal.

Cost–effective alternative
The alternative that—
a. Maximizes benefits and outputs when costs for each alternative are equal (the most effective alternative).
b. Minimizes costs when benefits and outputs are equal for each alternative (the most efficient alternative).
c. Maximizes differential output per dollar difference when costs and benefits of all alternatives are unequal.

Cost-effectiveness analysis
See benefit-cost analysis.

Current costs
Costs incurred in the current accounting period.

Cost element
Basic unit of cost, such as labor or material. Related basic units are accumulated to form the total cost of each cost kind (see cost kind).

Cost–estimating relationship
A numeric expression of the link between a characteristic, a resource, or an activity and a particular cost connected with it. The expression may be a simple average, percentage, or complex equation derived by regression analysis that relates cost (dependent variable) to physical and performance characteristics (independent variable). For example, annual cost of maintenance of the structure may be determined, using regression analysis, to be a function of its age. The cost-estimating relationship shows how the values of such independent variables are converted into estimated costs.

Costing
The process of estimating or allocating costs for a specific activity, project, or organization.

Cumulative net present value
The total of the discounted annual cost for the year in question and all preceding years of the project.

Current costs
Costs incurred in the current accounting period.

Current dollars
Convention used to show purchasing power in the year spent. Prior costs stated in current dollars are the actual amounts paid out. Future costs stated in current dollars are the actual amounts expected to be paid, including amounts caused by future price changes (inflation).

Current market value
The amount for which an item could be sold in today's market.

Data
Numerical information of any kind.

Depreciation
A reduction in the value of an asset estimated to have accrued during an accounting period due to age, wear, usage, obsolescence, or the effects of natural elements such as decay and corrosion.

Design year
The year immediately before the budget year and immediately after the guidance year. It is the year design begin in a construction program.

Differential inflation
The difference in inflation between the rate for the overall economy and the rate for a particular cost which is either greater or less than the general inflation rate.

Direct cost
Any cost that can be identified specifically with a final cost objective. Direct costs are not limited to items that are incorporated in the end product as material or labor. Costs that can be identified specifically with a product or service are direct costs of that product or service. All costs identified specifically with other products or services are direct costs of those products or services.

Direct labor
That portion of salaries and wages that, as a practical matter, can be identified with and charged only to a specific product or service.

Direct material
The costs of such goods as raw material, parts, subassemblies, components, and supplies that, as a practical matter, can be identified specifically with the product or service (the final cost objective) under review.

Disbenefit
An undesirable result; an offset to benefits.

Discount rate
Interest rate used to relate present and future dollars. Expressed as a percentage and used to reduce the value of future dollars in relation to present dollars to account for the time value of money.

Discounted payback period
Time required for the accumulated present value of savings of a proposed alternative to equal the total present value of its investment costs.

Discounting
Technique for converting various cash flows occurring over a period of time to equivalent amounts at a common point in time, considering the time value of money, to allow valid comparisons.

Discounting convention
A method of discounting costs, either at beginning-of-year, mid-year, or end-of-year.

Economic analysis
A systematic method for quantifying the cost and benefits of alternative solutions for achieving an objective in order to find the most efficient (economical) solution. Structured method to identify, analyze, and compare costs and benefits of the alternatives.

Economic life
Period of time over which the benefits from an alternative are expected to accrue. The economic life of an alternative starts in the year it begins producing benefits. The economic life is not necessarily the same as physical life or technological life.

Economic savings
Savings resulting from a decision that yields improved effectiveness or efficiency. Although the alternative may cost more, combat readiness or mission ability improvements may be more valuable than the amount of added cost. The short–term cost may be higher, but long–term costs may be lower, resulting in an economic saving. A short–term cost may produce an economic saving by deferring or eliminating a future cost.

Effectiveness
The performance or output received from an approach or project. (See Output and Output measures.)

Efficiency
The degree to which output performance is optimized for a given distribution of inputs.

Energy resources
Resources that can be used to provide energy needs. Energy resources, in general use, are liquid petroleum products, coal, natural gas, liquefied petroleum gas, purchased electricity, purchased steam, nuclear fuel, solar radiation, and batteries. Special energy resources that may apply in specific cases are manpower, animal power, special gases, special liquids, liquefied gases, solid fuel, chemicals, wind, waves, and geothermal conditions.

Engineering estimate
Predictions of costs based on detailed measurement or experiments and specialized knowledge and judgment. Also called, “engineering method of cost estimating.

Equipment
Machinery, furniture, vehicles, or machines used or capable of being used to manufacture supplies or to perform services or for any administrative or general plant purposes.

Equivalent uniform annual cost
The amount of money, which if paid in equal annual installments over the life of a project, would pay for the project. That is, the discounted value of this hypothetical uniform cost stream is equal to the actual estimated present value of project costs. The alternative with the lowest uniform annual equivalent amount is the least costly alternative.

Estimated cost
A general term indicating that the cost figure presented is not the result of actual operations. The estimate may be based on past experience with like operations, or it may be based on detailed analysis including estimates of all relevant expense items.

Estimating cost
The process of determining a future or past result in terms of cost based on available data.

Expected annual cost
The expected annual dollar value (in constant dollars) of the number of resources, goods, and services to set up and carry out a project.

Expected cost or expected value
A statistical term specifically identifying the results of applying a probability distribution to actual or estimated performance values.

Expense item
A basic unit of cost, such as labor or material. Related basic units are accumulated to form the total cost of each cost kind. (Also, see cost element and cost kind.)

Externalities
Benefits and costs that affect parties other than ones directly involved. Also called "spillovers". An external economy is a benefit received by one from an economic activity of another for which the beneficiary cannot be charged. An external diseconomy is a cost borne or damage suffered consequent to the economic activities of others for which the injured is not compensated. For example, a city downstream benefits from, but does not pay for, a water pollution control program instituted by a military base upstream.

Feasible alternative
An alternative that is affordable and executable and, when specified, meets a minimum level of benefits for effectiveness.

Final cost objective
A cost objective that has both direct and indirect costs allocated to it and, in the cost accumulation system, is one of the final accumulation points.

Fiscal year
The accounting period for which annual financial statements are regularly prepared. The Government's FY begins on 1 October and ends on 30 September.

Fixed cost
Cost incurred whether or not any quantity of an item is produced. These costs do not fluctuate with variations in output. For example, the total rent of a large apartment complex might be considered a fixed cost because it does not vary with the number of units occupied.

Fringe benefits
Allowances and services provided to employees as compensation in addition to basic salaries and wages.

Full costs
The total of all direct and indirect costs allocable to a product or service.

General and administrative expense
Any management, financial, or other expense that is incurred by or allocated to an organizational unit and which is for the general management and administration of the unit as a whole. general and administrative expense does not include those management expenses whose beneficial or causal relationship to cost objectives can be more directly measured by a base other than a cost input base representing the total activity of the unit during a cost accounting period.

General price index
The ratio of a year's price level to a base year price level for all goods and services. This is sometimes called composite price index or general inflation rate.

Goal
The end purpose of a project. The end toward which all efforts are directed.

Government–furnished facilities and equipment
Facilities and equipment in the possession of or acquired directly by the Government and subsequently delivered or otherwise made available to the contractor.

Guidance year
The year preceding the design year. It begins with the Army guidance documents providing general instruction and the present policies of HQDA. Included are military construction programs and program dollar guidance for each Major Command's MILCON program.

Historical cost
Price based on actual monetary (or equivalent) outlay, determined after the fact. Any method of cost determination can be used, but the sources of costs must be documented in the source derivation part of the EA report.

Imputed cost
Costs that do not involve an actual expenditure of funds; hence, they do not appear in the final records. These are costs not actually incurred because of the nature of the transaction but they should be included in the decision process.

Incremental cost
A cost increase or decrease that results from a change in operations. These costs are often stated in terms of cost change per unit of change. Also, they are sometimes stated in terms of total cost of a change in operations.

Indirect costs (overhead)
Any cost not directly related to a single final cost objective, but related to two or more final cost objectives or with at least one intermediate cost objective. Indirect cost includes overhead and other fixed costs and groups of resources other than direct costs required to add up all segments of total cost. For example, the cost of bookkeeping is often not identified with a single type of output.

Industry(for this publication use only)
Statistical device for measuring changes in groups of data; serves as a yardstick of comparative measure, expressed as an index number.

Inflation
A persistent rise in the general level of prices over time which results in a decline in the purchasing power of money. Measured by changes in priced indices relative to some base year.

Inherited asset
An existing asset that will be used in an alternative. If the asset could be used for some other purpose or sold, its value is included as a cost in the alternative. If it has no use or value except in the alternative, no cost is included.

In–house performance
The performance of services or manufacture of products by Army military or civilian personnel to support Army functions. This includes in–house Army performance of commercial– or industrial–type functions for DOD components and other Federal departments and agencies.

Insurance costs
The cost to the Government arising from liabilities and losses not covered by insurance. The costs are incurred in agreement with the Government's policy of acting as a self–insurer. (See imputed costs.)

Interagency support
Products or services furnished from the capacity of another Government agency or organization to the agency that will provide the product or service being estimated.

Interest
A price (or rent) charged for the use of money.

Investment costs
Costs associated with acquisition of real property, nonrecurring services, nonrecurring O&M (start-up) costs. These are usually one–time costs, although they may be spread over more than 1 year (such as construction costs).

Labor time standard
A pre-established measure, in temporal terms, of the quantity of labor required to do a task.

Lead time
The period between initial funding or decision and commencement of the economic life.

Least–least cost alternative
The option producing at less cost, the same of greater quantity of a given output than another alternative.

Life–cycle costs
The total price of an item or system over its life cycle. Includes initial investment, maintenance and repair, operations, utilities and, where applicable, disposal.

Maintenance and repair
Cost incurred to keep buildings and equipment in normal operating condition.

Net present value
The cumulative discounted amount that also includes the discounted value of the residual amount.

Nonrecurring cost
Cost that occurs on a one–time basis as compared with annually recurring costs.

Objective
The result to be achieved by the project being studied. It must be stated in unbiased terms

One–time costs
The nonrecurring costs to the Government when it either starts or ends an in–house activity as a result of a decision to change the source, character, or condition of a product or service.

Operational costs
Utilities, custodial, and other routine costs incurred in operating a facility, not including maintenance and repair.

Operations overhead costs
The indirect costs that are necessarily incurred during a FY to produce or deliver the products or services being provided by an organizational element.

Opportunity costs
Amount of money associated with expending capital resources instead of investing them. If funds are expended, the potential that might be gained from investing them is lost. In the private sector, opportunity costs are equivalent to interest rates adjusted for inflation.

Optimization
A determination of the best mix of inputs to achieve an objective.

Other direct costs
All those direct costs (exclusive of direct labor and direct material) that are identified as having been incurred for a certain product or service.

Output
Products, functions, tasks, services, or capabilities that an organization exists to produce, accomplish, attain, or maintain.

Output measures
Useful descriptions of functions, tasks, or missions performed by an organization and of capabilities possessed.

Overhead rate
A percentage, or monetary unit related to a quantitative measure, derived by dividing an indirect cost pool by an allocation base.

Overtime and other premium pay
Amounts added to basic salaries for working longer than the regularly scheduled hours or under unusual conditions.

Ownership cost (or cost of ownership)
A product’s or service’s pro-rata share of the depreciation and cost of capital applicable to the fixed assets required for performance.

Payback period
The time required for the stream of cash proceeds and cost savings produced by an investment to equal the original cash outlay of the investment. This is one of several project evaluation methods. It is also called the payoff period and cash recovery period.

Period of analysis
Time span over which an EA takes place; that is, the time over which alternatives are compared.

Physical life
Estimated number of years that a piece of equipment or building can physically be used in accomplishing the function for which it was procured or constructed.

Present value
Monetary expenditure (or savings) multiplied by the discount factor. The resulting figure represents the worth of the future amount in base year dollars.

Price
Dollar amount for which a good or service is bought or sold.

Primary analysis
An economic analysis performed when the objective is to change the status quo (present method of operation) in order to achieve a financial savings to the Government.

Probability
Numeric expression of the likelihood or chance of occurrence of a given event or outcome. It is expressed as a number ranging from zero to one.

Program year
The year funds are made available for construction. The first year of the execution phase for each military construction program. It follows the budget year and is the current FY.

Project
A major mission–oriented endeavor that fulfills statutory or executive requirements, and that is defined in terms of the principal action required to achieve a significant objective.

Proposal
Any offer or other submission used as a basis for pricing a contract, contract modification or termination settlement, or for securing payments thereunder.

Quantification
Measurement in terms of price of the inputs, outputs, or benefits of a program.

Range
The difference between the smallest and largest quantities in a statistical series arrayed according to size.

Real interest rate
Interest rate with inflation removed, which is used to determine the real rate of return on investment. For an EA, real interest rate is calculated by subtracting current rates of inflation from current interest rates for long term U.S. Treasury securities.

Real property
Land, utility plants, distribution systems, buildings, structures and their improvements.

Recurring costs
Expenses for personnel, material consumed, operating overhead, support services, maintenance and other items that are charged annually or repetitively in the execution of a given program or work effort.

Regression analysis
Evaluation for determining the relationship between two or more variables. Determines the change in a dependent variable caused by changes in one or more independent variables. The relationship may be linear (straight line) or curvilinear.

Rent
The cost incurred for the use of another entity's tangible assets (land, plant, machinery, and so forth) in providing the product or service being estimated.

Replaced asset
An asset substituted with an alternative. It is made available for other use by the Army or is advertised for sale. Its value is subtracted from the NPV of the alternative.

Residual value
The remaining monetary value, if any, of an alternative at a specified point in time.

Resources
Facilities, personnel, equipment, supplies and other items required for an alternative. Once resources are determined, their value in dollars can then be estimated.

Return on investment
The amount of revenue (savings) received from an investment.

Risk
In decision theory, the distinction is made that risk is quantifiable, while uncertainty is not. In situations of risk, the probabilities connected with potential outcomes are known. The term may be connected with situations of repeated events, each individually unpredictable but with the average outcome highly predictable. In situations of uncertainty, the probabilities are not known. This pamphlet uses the terms risk and uncertainty interchangeably.

Savings
Reduction in costs achieved without reduction in performance. It is always computed with respect to the existing course of action or status quo in an economic analysis.

Savings to investment ratio
Ratio of discounted future cost savings (or avoidance) to the discounted investment cost necessary to effect those savings. An SIR of 1 indicates that the present value of savings is equal to the present value of investment.

Secondary analysis
An economic analysis performed when there is a new requirement to be met or the existing facility is not adequate.

Segmented marketing housing analysis – (housing market analysis)
An analysis of private rental housing assets available for Army housing needs within a 1-hour commute or 30 miles from the installation at peak traffic periods.

Sensitivity analysis
An examination of how the EA results may change with respect to changes in the costs or timing of costs in an alternative(s). As a minimum, the effect of changes in high–cost elements and questionable assumptions will be studied.

Standard level user charge
The amount which GSA assesses Federal agencies for their assigned space in GSA–controlled buildings. This SLUC rate is a composite of the following three ingredients:
a. The fair annual rental appraisal rate for space, utilities, and normal services.
b. An escalation of this rate.
c. An added charge for standard protection.

Standard military rate
Standard rates set by DOD for expensing military personnel services. These standard rates are a composite of military basic pay, incentive, special pay, and certain other expenses and allowances.

Standby maintenance costs
The costs necessary for the upkeep of property held in a standby status to assure contract performance. This maintenance neither adds value to the property nor appreciably prolongs its useful life. Rather, the maintenance keeps the property in an efficient operating condition so it will be available for possible use in case of nonperformance by the contractor.

Start year
The first year in which costs are incurred—often the first year of the analysis period.

Sunk costs
Unrecoverable investment costs of past periods or unavoidable costs committed to a project (such as contract termination costs). Sunk costs have no bearing on the results of comparative cost studies and economic analyses, except economic program evaluations.

Support costs
Costs incurred by one organizational unit for the benefit of another.

Tangible capital asset
The number of years a facility or piece of equipment will be used before it becomes obsolete due to changes in technology.

Technological life
The estimated number of years before technology will make the existing or proposed equipment or facilities obsolete.

Terminal value
(See residual value.)

Time value of money
The concept that use of money costs money; a dollar today is worth more than a dollar tomorrow because of the interest costs.

Total annual outlays
The sum of all costs for a given year.

Uncertainty
The state of knowledge about outcomes in a decision which is such that it is not possible to assign probabilities in advance. Doubt or ignorance about the magnitude of cost/benefits or their timing. A technique for assessing the effect of uncertainty on EA results is the sensitivity analysis.

Uniform annual cost
(See equivalent uniform annual cost.)

Value
The desirability, utility, or importance of an item. The worth of an item in money. Often represented by price. In economic analysis the value of costs and benefits is given in dollars. The value of a good or service is what a consumer is willing to give up to have it.

Variable costs
The portion of total cost that depends on output and tends to vary with changes in production level.

Wash cost
A cost that is identical for all alternatives being evaluated. A wash cost is to be omitted from the analysis because it cannot alter the decision. It increases all alternatives by the same amount during the same time periods. Wash costs must not be omitted from an analysis which included calculation of statistics such as averages, SIR, and percentages.

Work statement (statement of work)
A comprehensive description of what is to be done including performance standards. The work statement should describe all requirements, such as duties, tasks, responsibilities, frequency of performance of repetitive functions, and requirements for furnishing facilities and materials.

Section III

Special Abbreviations and Terms

This section contains no entries.