# Sustainable vs. Traditional Facility Projects:

# A Holistic Cost Management Approach to Decision Making

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## Introduction

Despite its commitment to developing sustainable facilities, the military is experiencing difficulty in implementing the concept due to the way in which funding is allocated to projects. Installation personnel responsible for developing project estimates have no way of accurately estimating the first costs of a sustainable project, let alone potential life cycle cost impacts of sustainability. In many cases, the only method available for estimating sustainable project costs is to add a contingency factor to the estimate for a traditional project to cover anticipated increases in design costs, material costs, and other project costs. This approach inhibits the implementation of sustainability for two reasons:

1) projects are typically funded based on efficiency of first cost, meaning that projects with a higher parametric cost estimate are less likely to get funded; and

2) adding a contingency to the project estimate means that even if the project does get funded, there is no incentive to seek cost savings since the money will be lost if it is not spent – this creates a self-fulfilling prophecy of increased costs for sustainable projects.

A better approach to cost estimating is needed if the military is to implement sustainability in its capital projects. Not only must we develop better methods for accurately estimating first costs of sustainable projects vs. their traditional counterparts, but also we must take into account the entire set of costs associated with a project in order to make project decisions that make the best use of public money. This paper presents a framework for understanding project costs from a holistic standpoint, and establishes objectives and requirements for developing a cost model that permits accurate understanding of the true cost implications of sustainable projects.

## The Economics of Sustainable Projects

Figure 1 provides a means for examining expectations about sustainable capital project costs. The grid represents a way to plot the relative cost of a sustainable project vs. its traditional counterpart in terms of both life cycle and first costs. Figure 1(a) shows what most people expect about a sustainable project: it will cost more in the beginning, but will likely save money over the whole life cycle due to waste reduction, increased durability, reduced operations and maintenance requirements, etc. This expectation is illustrated by the red circle in the lower left quadrant of the diagram.

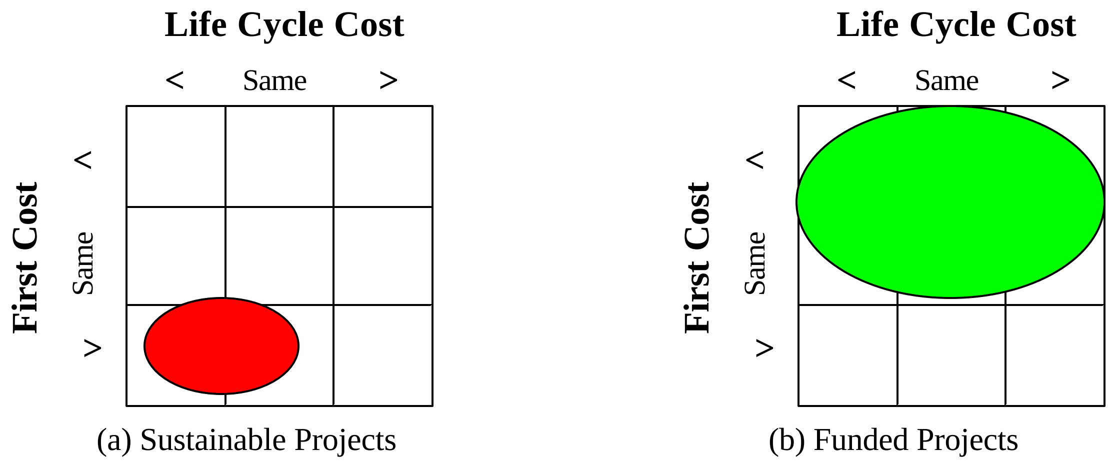


**Figure 1:** Expectations about Sustainable Project Costs

Yet, within the present structure for funding projects, the only projects that will be funded without special intervention lie within the region indicated by green in Figure 1(b), i.e., those that cost the same or less from a first cost perspective. In many cases, funding constraints mean that minimum first cost is the goal, even though overall life cycle costs may be greater (the third column in the diagram). This sub-optimal result is possible because the sources of money for first cost vs. operations/maintenance cost are different and disconnected (i.e., the "color of money" problem – describe further?).

Why is the military trying to implement sustainable projects when such projects do not conform with its funding process? Reasons include variety of potential benefits:

- Reduced costs of consumption, waste disposal, and noncompliance
- Reduced liability and environmental risk
- Improved use of assets, particularly human assets
- Reduced operational and disposal costs
- Reuse of facilities that otherwise would be disposed
- Preparedness for future regulations and requirements

Each of these benefits reflects a potential cost savings for the military, although many of these kinds of costs are not typically associated with specific projects and the associated decision processes behind their funding. If these potential benefits can be realized, then sustainable projects will truly have an economic advantage over their traditional counterparts. A new way of modeling project costs is needed that takes into account *all* the costs and benefits associated with projects, so that the project which makes most sense from a whole life cycle perspective is implemented.

## Holistic Cost Management

The concept of holistic cost management (SFI 2000) considers the following from the very beginning of a project:

- What will be the impacts of design/construction decisions on life cycle costs?
- What opportunities exist to *offset* increases in first cost for design improvements?
- What externalities should be considered that could result in a better decision about costs?

Instead of the two-dimensional representation of cost shown in Figure 1, holistic cost management expands the figure along a third dimension to include additional cost/benefit considerations that are associated with the project. Figure 2 illustrates the revised cost model.

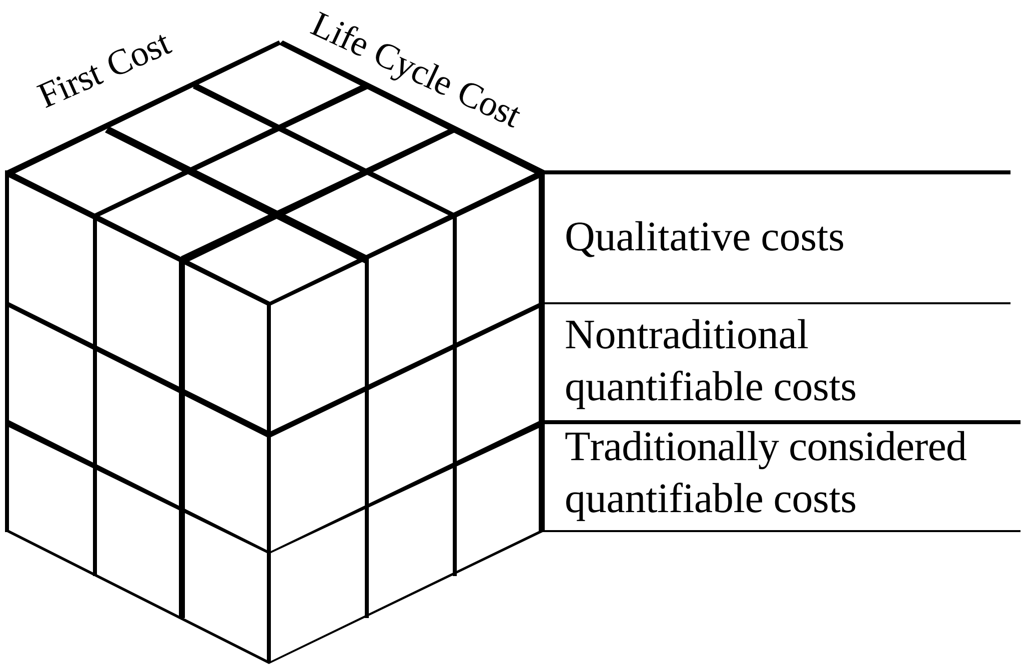


**Figure 2:** Revised Whole Project Cost Model (SFI 2000)

### Traditionally Considered Quantifiable Costs

The bottom layer of the figure represents the two-dimensional cost comparison shown in Figure 1. This layer represents traditionally considered, quantifiable costs that are typically calculated as part of project planning. Examples of these kinds of costs are shown in Table 1.

**Table 1:** Traditionally Considered Quantifiable Costs

| FIRST COSTS | LIFE CYCLE COSTS |
|---|---|
| Site acquisition<br>Design costs<br>Project management costs<br>Construction costs...<br>• Labor<br>• Materials<br>• Equipment<br>• Contingencies<br>• Financing and other "costs of money"<br>• Commissioning/turnover costs | Operation/maintenance costs...<br>• Labor<br>• Materials<br>• Equipment<br>• Energy<br>• Water<br>Repair/remodel/rehab costs…<br>• Design costs<br>• Labor<br>• Materials<br>• Equipment<br>• Contingencies<br>• Financing<br>• Turnover |

Considering the kinds of costs shown in Table 1, is it true that sustainable projects always cost more up front? Some evidence would suggest that sustainable projects can actually cost *less* than their traditional counterparts (e.g., Mogge 2000, Hawken et al. 1999). Whether or not sustainable projects cost less from a first cost standpoint is still up for debate, although sustainable project strategies such as HVAC downsizing due to tight envelope design, reuse of developed sites to eliminate infrastructure extension costs, and reduction of hazardous materials and construction waste can certainly offer initial savings. Other factors that may result in reduced quantifiable costs for sustainable projects include:

- Learning Curve – as sustainable products and strategies become more familiar to designers and builders, less effort will be required to use them correctly (Arrow A in Figure 3)
- Economies of Scale – as demand increases for sustainable technologies in the marketplace, production and distribution networks will grow and become more efficient (Arrow B in Figure 3)
- Resource Scarcity – as many of the materials presently used in building (e.g., fossil fuels, old growth timber, mineral-derived products) become more scarce, their costs will increase and the cost of using alternatives will become relatively less expensive (Arrow C in Figure 3)
- Stricter Legislation – as environmental, safety, and occupational health (ESOH) regulations become more restrictive, projects that have lower risk of ESOH threats will become relatively less expensive (Arrow D in Figure 3)

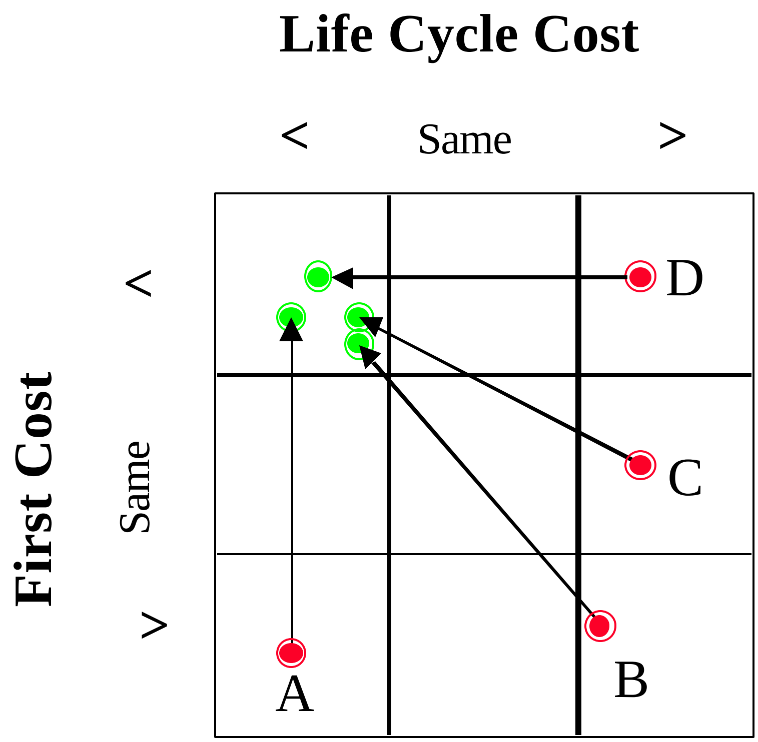


**Figure 3:** Influences on the Cost of Sustainable Projects

All of these external influences will tend to give advantage to sustainable projects from an economic standpoint, at least in the long run. But what about the present decision environment? What other considerations about sustainable projects offer economic advantages?

**Nontraditional Quantifiable Costs**

The second layer in the holistic project cost model consists of nontraditional but quantifiable costs. These are costs that can be quantified in terms of their economic impact, but which are not traditionally considered as part of the project decision process. Table 2 shows examples of these kinds of costs.

The costs listed in Table 2 are broken into two categories, both of which have the potential to impact first and life cycle costs. The first category, definite costs, includes all costs that will definitely happen as part of the project, but are typically not considered as part of project costs but rather covered as part of overhead or administrative costs. The second category, contingent costs, consists of costs that may or may not occur – their probability of occurrence is less than 1.0. In other words, there is some likelihood that they will occur, and their total costs can be estimated using probabilistic methods such as decision trees. Table 2 lists examples of both kinds of costs. Although the listing is not comprehensive, it illustrates the kinds of costs for which dollar values could be calculated but are typically not included in project decision making.

**Table 2:** Nontraditional Quantifiable Costs

| DEFINITE COSTS | CONTINGENT COSTS |
|---|---|
| Qualification of suppliers/contractors<br>Reporting and record-keeping<br>Monitoring and testing<br>Spill response readiness<br>Recycling/waste management<br>Facility decommissioning costs<br>Disposal costs | Future compliance costs<br>Future liability/damage costs<br>Remediation costs<br>Responses to future releases or presently unknown hazards<br>Impacted productivity and/or absenteeism<br>Impacted staff retention |

### Qualitative Costs

The third layer of the holistic cost model consists of qualitative costs – those costs that have some real impact but are difficult to quantify because of societal values and other measurement challenges. It is at this level that sustainable projects truly dominate traditional projects in their impact reduction; however, the difficulty of assigning actual costs and benefits to specific projects is significant and therefore not typically considered as part of project decision making. Table 3 lists some of the cost items that are classified under this layer.

**Table 3:** Qualitative Costs

| INTERNAL COSTS | EXTERNALITIES |
|---|---|
| Impacts on quality of life<br>Value of relationships with surrounding community<br>Value of environmental image | Costs borne by society as a whole, e.g.,<br>• Global warming<br>• Ozone depletion<br>• Deforestation<br>• Resource degradation<br>• Ecosystem degradation<br>• Species/biodiversity loss<br>• Air pollution<br>• Water pollution |

Costs can be broken into two categories at this level: internal costs, and external costs. Internal costs are those difficult to quantify costs experienced directly by project stakeholders. Externalities, on the other hand, are generally borne by society as a whole. While projects have some individual contribution to these costs, the net cost is a result of all human activities, and allocating specific responsibilities is difficult. Methods exist to assign costs to these kinds of impacts, and are used frequently in risk analysis and policy development. These methods include:

<u>Indirect methods</u> - price is inferred from actual choices to which we can assign monetary values, such as choosing where to live. May examine:

- Averting behaviors - how much people will pay to fix environmental damage; the cost of cleanup
- Weak complementarity/travel cost - e.g., where the value of cleaner water is assumed to be connected somehow to visits to a lake

- Hedonic market methods where the price of a house or a job can be decomposed into attributes, one or some of which are environmental attributes.

Direct methods - a.k.a contingency valuation. Direct questioning about willingness to pay or willingness to accept compensation in exchange for environmental damage of some sort.

While costs can indeed be associated with the qualitative layer of the project cost model using these methods, their credibility varies widely depending on the context of use.

**Holistic Cost Modeling**

The ultimate outcome of considering the full spectrum of costs associated with a project is a true picture of what costs and benefits will stem from each alternative over its whole life cycle. If all costs are considered, then actions which might ordinarily come back to haunt the decision maker (such as endangered species habitat disturbance or use of hazardous materials) can be adequately considered for the risk they truly represent. Figure 4 shows how sustainable projects compare with traditional projects when all these factors are considered. The sustainable project, indicated by the green dots, has lower non-traditional and externality costs compared to the traditional project, indicated by red. This two-dimensional representation corresponds to looking at the three-dimensional model from the side, and reducing first cost and life cycle costs to a single metric such as net present value for comparison purposes.

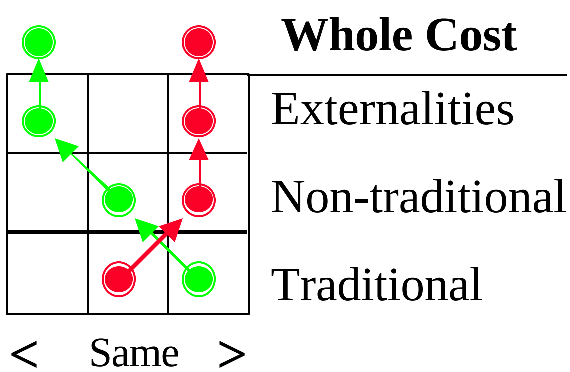


**Figure 4:** Sustainable vs. Traditional Projects from a Holistic Standpoint

## Implementing Holistic Cost Management

The previous sections described a framework for understanding project costs from a holistic standpoint. This framework illustrates the kinds of costs that could and should be considered in making project decisions that are in the best economic interests of the military and the taxpayers whose funds it uses. Actual implementation of the framework in the project decision process entails a number of complexities, described in the following subsections.

## Role of the Cost Model

Cost information is needed at various phases of a project's life cycle, beginning with the initial planning estimate developed for funding request via DD 1391, through design estimates used to manage project costs, through estimates of costs for maintaining the facility at a desired level of performance. The two primary roles of a cost model are:

1) to communicate a request for funding; and
2) to provide a baseline for managing spending during implementation.

One of the biggest challenges for military cost estimators in the planning phase of a project is to come up with an accurate project estimate that will result in sufficient funding to meet the goals of the project without being too costly for the project to get funded. The long lead time for funding requests (5-7 years on average between initial funding request and project completion) means also that the state of the art in building technology and changes in functional requirements can result in a different project than was originally anticipated.

When used to communicate a request for funding, a cost model serves as a means of communication between the installation personnel requesting funds and the Assistant Chief of Staff or Headquarters level personnel who allocate funds. To adequately function in this role, the cost model needs to have the following attributes:

1) it must be usable by installation personnel given the data they have available at the time of estimate preparation; and
2) it must convey output that clearly explains and justifies the funding request so that funding personnel understand the implications of their decisions.

As such, the cost model must meet the needs of both modeler and recipient to serve as an effective means of communication. Understanding the needs, information resources, and other characteristics of these parties is the most critical first step in developing a tool based on the holistic cost model.

Likewise, when used to manage spending during project implementation, the cost model must contain sufficient detail to allow project managers to discriminate between factors that drive project costs, and should meet the needs of designers who are considering the impacts of design decisions throughout the design process.

## Factors Related to Customized Design

A challenge of cost modeling for sustainable projects is capturing the customized features of designs that are optimized for their specific situations, e.g., location, physical and nonphysical context, etc. In general, a project that is customized to be responsive to and take advantage of its context will not only be more sustainable, but also more cost effective. However, its costs will be much more difficult to estimate in the planning and early design phases because of the need to make assumptions about systems used and their interactions. The success of traditional cost modeling tools used early in the life cycle (e.g., PACES, MCACES, etc.) lies primarily in their ability to make accurate assumptions about building configurations and the influence of location on those features. In short, they rely on the underlying assumption that most buildings built will be fairly similar, with small adjustments made to some systems based on location (e.g., HVAC), but with most systems remaining constant. From a sustainability standpoint, however, a building in Phoenix should look (and behave) nothing like a building in Seattle – differences in climate, for example, should dictate that the envelope, mechanical and electrical, and other systems be completely different in order to match the system with its specific locational requirements.

As design progresses, the need for assumptions decreases and making accurate cost estimates becomes easier. However, the design strategy used greatly influences the ease and accuracy of cost estimating early in the planning/design process. A design strategy of component substitution, where a baseline building design is modified by substituting more sustainable products, is reasonably easy to model from a cost standpoint, as long as accurate information is available about the new products. On the other hand, a whole design optimization strategy may result in a building that is unlike any reference building, making early estimates extremely difficult to determine. However, whole design optimization is the only approach in which it is possible to effectively manage the *first cost* of projects, by using increased performance in one system to offset the requirements (and cost) of another.

**Factors Related to Method of Cost Model Construction**

An additional challenge for modeling the cost of sustainable projects has to do with methods for developing cost models in the first place. As described in the previous section, many excellent cost models exist for traditional projects that are based on a large experience base and population of past projects. Parametric models can be constructed from this knowledge base that are extremely accurate for projects similar to the population of past projects. However, there are relatively fewer examples of sustainable projects that can be used to construct parametric models of cost. Furthermore, those that exist may have cost distortions due to some of the factors described earlier, e.g., the self-fulfilling prophecy of design contingencies, learning curve and economy of scale effects, and lack of integrated design strategies. Any cost model for sustainable projects will have to be built in a way that factors out existing biases against sustainability that are inherent in the system. At later stages of design, quantity takeoff methods of estimating will provide a sound basis for estimating the first costs of sustainable projects. Earlier in the design stage, however, estimates may need to be based on examples of best practice rather than an overall population of cases, as has been the basis for development of most other parametric models.

### Factors Related to Nontraditional and Qualitative Cost Estimation

The final set of factors influencing the implementation of the holistic cost model pertain to identifying what kinds of costs should be included in the analysis, and how they should be estimated. As discussed earlier, including costs and benefits not traditionally part of project decision making (such as future liability, quality of life, and others) provides a more accurate representation of the true costs associated with a project, and better illustrates the true advantages of sustainable projects over traditional projects. Estimating these costs, however, can be difficult. A considerable body of literature is emerging to document the benefits of sustainable building, ranging from occupant health and productivity impacts, to reduced impacts on natural ecosystems and resource bases, to reduction in liability, to improvement in overall quality of life and community relations.

A comprehensive inventory of these kinds of costs, along with metrics for quantifying the influence of each, is needed in order to truly capture the influence of sustainability on a project. How to incorporate these factors into a holistic cost benefit analysis is also a challenge – estimating the likelihood of future liability, environmental risk, and influences on quality of life goes far beyond the traditional job responsibility of the construction estimator. If holistic cost management is to be implemented, tools must be developed that enable cost estimators to accurately and fairly consider impacts of this nature for different project scenarios.

## Recommended Next Steps

The purpose of this paper has been to propose a framework for understanding the costs of sustainable projects vs. traditional projects, and to identify some of the factors that must be considered in developing cost models to aid in project decision making. The ultimate goal of the paper is to initiate the process of developing such cost models. Toward that end, this final section proposes some of the next steps that should be taken to develop a cost model that can be used by military facility personnel to accurately assess the costs and benefits of sustainability.

1) Understand the environment of use – the first step involves understanding the context in which the tools will be used. Who are the users? During what phase of the project will the tool be used? What information is available as input to the model at various phases of the project? What outputs are required to meet the needs of both facility personnel and funding personnel?

2) Identify cost items that should be included – while this paper identified examples of the kinds of cost items that could be included for each layer of the holistic cost model, a more extensive examination of the costs associated with military projects is needed to ensure that all costs are accounted for. Additional research into the cost drivers for military operation at the installation and branch levels is also needed to ensure that all costs related to facilities are included.

3) Review existing quantification methods – this paper identified some of the existing methods for quantifying costs such as contingent valuation and quantity takeoffs, but a more thorough review of existing tools and methods is needed to determine which approaches have the greatest degree of validity given the information typically available to users of the tools.

4) Construct holistic cost model – based on existing methods for cost benefit analysis, a prototype cost model should be constructed that meets user requirements identified in step 1. The model should be validated against examples of both traditional and sustainable projects. It should also adhere to existing standards for interfacing with other tools such as energy modeling software, existing cost models, etc.

These four preliminary steps are needed to develop tools suitable for implementing the holistic cost management process. With lessons learned from implementation, the process of estimating sustainable project costs will gain accuracy and validity over time. By extending the scope of costs considered as part of project decision making, the true cost advantages of sustainable projects should emerge, encouraging the implementation of sustainability throughout the military.

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