The George Washington University

Determining the Best Building Construction Alteration Projects to Fund

<u>Prepared for:</u>

Dr. Ernest Forman
Management Science 224

<u>Prepared by:</u>

Johnson Payne
Derek Winogradoff

April 12, 1999
<u>Revised April 21, 1999</u>
Revised May 4, 1999

Abstract

The General Services Administration (GSA) has been in operation for 50 years and consists of three central management agencies for the Federal Government responsible for managing telecommunications, space, supplies and real estate. Within GSA, the Public Buildings Service (PBS) is one of the three Services and is responsible for managing over 8,000 properties (1,200 federally owned and 6,800 leased) and providing workspace environments for 1 million employees. PBS acts as a builder, developer, renovator, and lessor, providing all real estate management services, including disposal. Through the lifecycle of the federally owned properties, major alterations are necessary to ensure the buildings remain useful and valuable. To this end, projects needing alteration are proposed by 11 regional PBS Offices to Headquarters PBS every year. The project proposals presented by the 11 regional PBS offices must compete for limited funds. In this paper we explore how to determine which of those projects will be funded using the Analytic Hierarchy Process model and decision making software known as Expert Choice, Inc. Project selection results from TeamEC sensitivity analysis are further evaluated by performing an optimization analysis comparing costs and benefits based on the amount of monies available for funding. An efficient frontier graph was plotted to graphically depict the ratio of benefit to monies available. Finally, results are explained and the final project selections are enhanced through application of AHP.

Introduction

Every year, PBS receives numerous project proposals requesting funding for construction alteration. Funding is limited, so all project requests are not met. Therefore, a decision has to be made for which project will receive funding. Typically, approximately 40 projects are submitted for funding consideration. A team of Asset Managers from the Office of Portfolio Management evaluates the projects to determine which projects to fund. Numerous and complex objectives (criteria) are evaluated and entered into the model to help arrive at an appropriate determination. Generally, for 75% of the projects it is relatively easy to determine if they should be funded or not. The remaining projects are marginal projects where it is difficult to determine which should be funded with the remaining money. In our case, 8 candidate projects fell into this group, and PBS still had $70 Million available to fund projects. The Asset Manager Team uses the Analytic Hierarchy Process (AHP) model and Expert Choice software to facilitate this decision making process.

Candidate Project Presentations

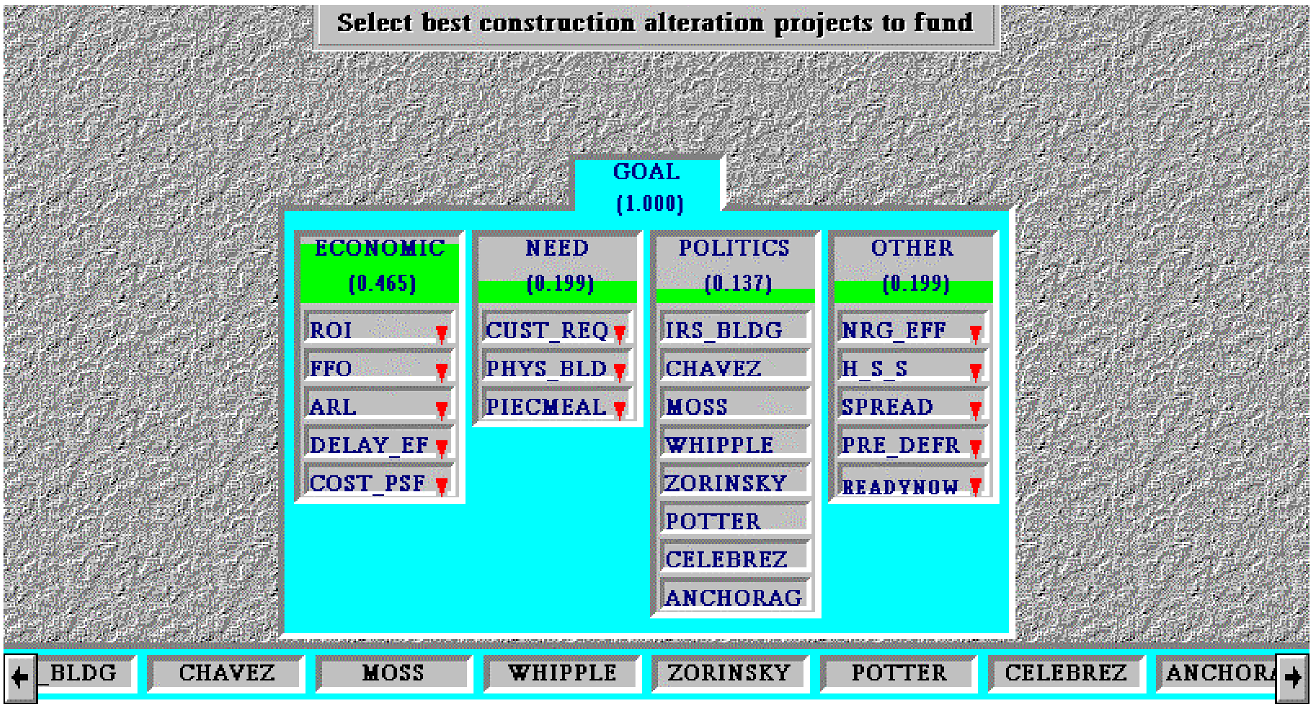
For the eight candidate projects, regional representatives conduct project proposal presentations for PBS Asset Managers team. The Asset Managers rely on information provided in the project presentations, prospectus, available data for criteria evaluation, intuition, and past experiences to make a funding determination. To facilitate this process, the AHP model was applied to arrive at a more objective funding decision.

Model Discussion and Analysis

Expert Choice, TeamEC software was chosen so that the various quantitative and qualitative objectives could be structured and compared to help reach a decision on which of the 8 projects would be funded. The TeamEC software utilizes the Analytic Hierarchy Process (AHP) model. By using the AHP model, the objectives can be placed into a structured hierarchy and a pairwise analysis can be performed to determine relative importance of the different objectives. The eight projects are identified as alternatives in the AHP model. The numerous objectives are structured into the model, with the main goal being "determining the best construction alteration projects to fund". By structuring the objectives in this fashion, competing objectives are analyzed in a logical way. The amount of funding is not considered in the decision making process until the end of the analysis.

Once the overall performance priorities are developed through the Expert Choice software, the results are compared to the available funding. A constraint that projects may not be partially funded, causes some projects that rank higher in the sensitivity analysis to be skipped over to make the best use of the available funds. Figure 1.1 is a screen view from TeamEC and shows the hierarchical structure for determining which of the 8 projects will be selected.

DIAGRAM OF MODEL LAYOUT
GOAL, OBJECTIVES AND ALTERNATIVES



GOAL WITH FIRST LEVEL OBJECTIVES

Figure 1.1

To develop and structure the model, the problem was identified as described above to arrive upon a goal. The alternatives were placed in the model and evaluated against the objectives. Numerous objectives were structured into the model at several node levels. At node level one, four main categories were identified: Economics, Need, Political, Other. Under each level one node (except politics), children of the related objective are identified.

The first level one node is identified as ECONOMICS and defined as “economic factors that impact construction projects”. Under the Economic node there are 5 categories itemized as follows:

1. ROI- Return On Investment for the proposed project
2. FFO- Affect of Project on Funds From Operations (Net Operating Income)
3. ARL- Project costs are within the Acceptable Reinvestment Level
4. DELAY_EF- Will project costs increase significantly if project is delayed
5. COST_PSF- Estimated total Project cost per usable Square Foot

The economic data was derived from available project data taken from the project prospectus for each project. The Economic objective is the only objective that uses “hard data” quantitative input.

The second level one node is identified as NEED and defined as “ How badly needed is the project due to insufficiencies in the present building”. Under the Need node, there are three objectives itemized as follows:

1. CUST_REQ- Is the building being modified to meet the customer/tenant requirements.
2. PHYS_BLD- Is the project going to be performed to maintain the physical structure of the building?
3. PIECMEAL- Can’t do standalone alteration projects to fill the need.

The third first level node is identified as POLITICS and defined as “Political considerations being determined when choosing a project”. While no children have been identified under the POLITICS node, it still has considerable influence in the final decision for which projects will be funded. Constituency pressures from all 11 regions makes it necessary to distribute funding as equitably as possible. This is partially considered through the OTHER node objective as well.

The final first level node objective is identified as OTHER and defined as “Other considerations when choosing projects to fund”. Under the OTHER node, there are five objectives itemized as follows:

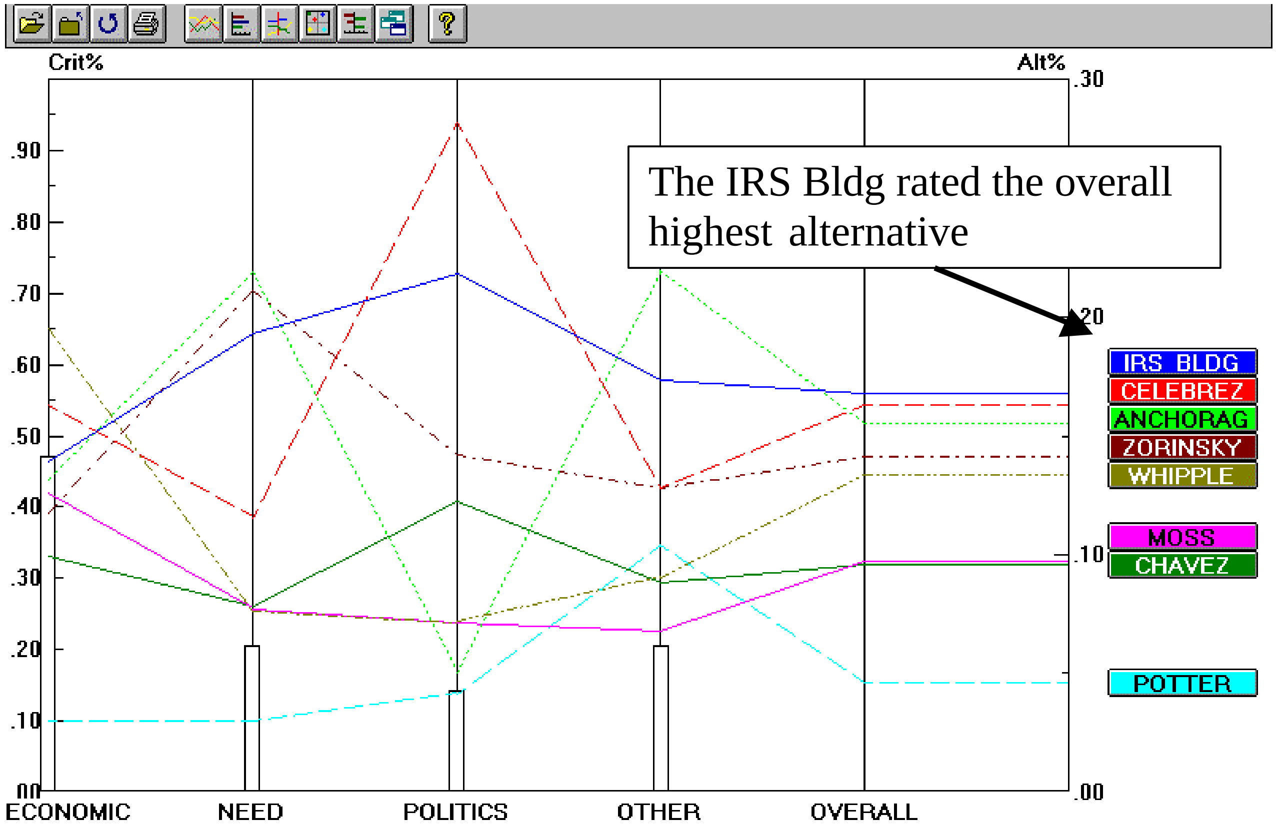
1. NRG_EFF- The degree to which the proposed project alteration is energy efficient.
2. H_S_S- What impacts there are on Health/Safety/Security Issues as they relate to the proposed project.
3. SPREAD- Have construction dollars been spent in the geographic region recently?
4. PRE_DEFR- Has the proposed project NOT been chosen recently, and how many times.
5. READYNOW- Can the proposed project be started by the 1^{st} quarter?

Using a pairwise analysis, all objectives were compared against one another and with the 8 alternatives. Within the pairwise comparison, the relative IMPORTANCE method was utilized when comparing all the objectives and alternatives. Inconsistency graphs were developed based on the pairwise analysis. For all analysis, the inconsistency Ratio was relatively low (less than .08). For the Economics objective, data values were entered instead of performing a pairwise analysis.

Model Results

When the sensitivity analysis was run, the various objectives were rated against each other in relative importance. The results of the sensitivity analysis are presented in figure 1.2 and indicate the overall ranking in performance. Generally, throughout the sensitivity analysis, when the 4 main objective weightings are adjusted to analyze resulting changes in ranking, the IRS Building is consistently on top. However, if the economic objective weighting is raised above .65, the IRS Building is no longer the top rated project proposal. Ideally, the performance priorities indicated in the sensitivity analysis graph would be utilized top down to fund projects if this tool agreed with all other methods used to make the final funding decision. However, after exporting the model results to MS Excel to add constraints and run an optimization analysis, the proposed project selection shifted with respect to cost verses benefit. The following shows the results of model running a sensitivity analysis. The optimization analysis results discussion comes later in the paper.

Figure 1.2 -**SENSITIVITY ANALYSIS- PERFORMANCE**



Alternative Approaches for Making Decisions

Alternative approaches to making a decision on which project proposal to fund includes several different methods. One of the main approaches currently used is making the decision based on the project presentations and prospectuses given to the Asset Managers by the regional representatives selling the proposals. Each regional representative is provided an opportunity to "sell" the proposals to the Asset Manager Team. The presentations (together with the project prospectus) are analyzed and evaluated independently by each Asset Manager. The Asset Managers then group together at the GSA headquarters and make the final selections based on their individual findings and the "hard data" included within the financial data supplied with the project proposal prospectus. This method of BOGSAT (Bunch Of Guys/Gals Sitting Around Talking) is effective but lacks substantive comparison analysis, making critical comparative rankings difficult.

In order to evaluate the validity of the model we will provide a summary of the model to the Asset Managers at the Office of Portfolio Management within the GSA. The model summary will then be compared with the project selections made by the Asset Manager Team. Validation of the model will also be compared with the common sense approach now used to determine the project funding selection. Finally, a validation of the model will be performed by comparison to the project financial analysis to determine feasibility.

Summary and Conclusions

Utilizing the Analytic Hierarchy Process, the decision of selecting which project proposals to fund becomes simplified. While AHP does not make the final decision for the decision-maker, it is clear that AHP is a powerful tool that can be used to help make a very informed decision. Rather than relying on intuition and experience alone, a much more thorough analysis and evaluation may be accomplished. In this case, a priority is clearly established for the projects to be funded. The priority ranking based on the sensitivity performance analysis is compared to the proposed cost of each project to develop a funding preference. If the sensitivity performance analysis graph is utitlized without the benefit of running an optimization analysis, an Asset Manager may be inclined to select the projects to fund based solely on the highest performance rankings. The final goal of "selecting the best construction alteration projects to fund" is achieved through use of the AHP model derived performance measures run through an optimization analysis using Microsoft Excel Solver. Looking at the funds available ($70M), the optimization yields the following decision variables (1 = projects chosen) and selected projects:

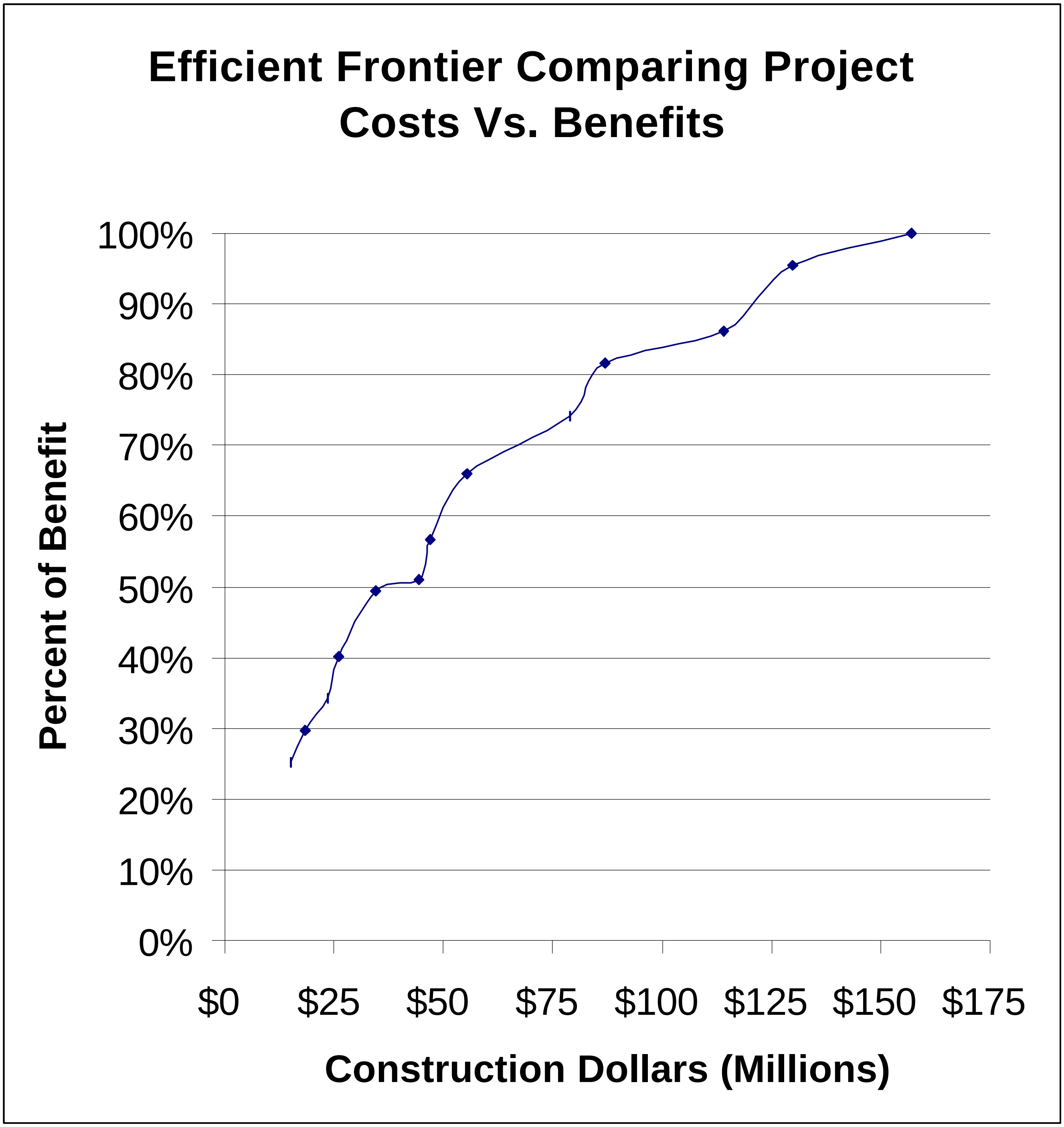
Proposed Buildings to Perform Projects	Proposed Project Cost (Millions)	Project Benefit	Decision Variable (projects chosen = 1)	Benefits of Projects Chosed	Cost of Projects Funded (Millions)
ANCHORAGE	$ 20.87	0.1663	1	0.1663	$ 20.87
CELEBREZE	$ 7.18	0.1463	1	0.1463	$ 7.18
CHAVEZ	$ 8.46	0.0926	1	0.0926	$ 8.46
IRS_BLDG	$ 31.78	0.1570	0	0.0000	$ -
MOSS	$ 7.81	0.1043	1	0.1043	$ 7.81
POTTER	$ 27.73	0.0450	0	0.0000	$ -
WHIPPLE	$ 10.99	0.1505	1	0.1505	$ 10.99
ZORINSKY	$ 42.65	0.1381	0	0.0000	$ -
				0.6600	**$ 55.31**
			Money Available for Projects (Millions)	**$ 70.00**	

Chart 1.1 Optimization Analysis Given Funding Limit of $70M

Optimization and Efficient Frontier Application for Project Selection

An Optimization Analysis Summary Table has been prepared and shown in Chart 1.2. Asset Managers can utilize the summary table to make intelligent decisions on funding. For the $70M limit, the optimization analysis charts 1.1 and 1.2 indicate that there would be approximately $15M left unused. This information may used by the managers to determine if the funding limit can be adjusted to include more projects or if the unused funds should be set aside for possible change orders or unforeseen conditions causing construction costs to escalate beyond the original estimate.

An efficient frontier analysis was performed to maximize the benefit based on funds available. It should be noted that the project selection varies extensively if funding limits are adjusted upward or downward, thus, playing a critical role in the final project selection. On the Efficient Frontier Graph 1.1, the optimal condition (given the funding limit) is shown in blue lines. With a funding limit of 70M available for projects, an optimization analysis yields funding for five projects: Ancorage, Celebreze, Chavez, Moss and Whipple. These five projects will be recommended for funding to the Asset Managers based on this comprehensive analysis.



Graph 1.1 Efficient Frontier Comparing Project Costs vs. Benefits

References

1. Saaty, Thomas L., *Decision Making for Leaders, The Analytic Hierarchy Process for Decisions in a Complex World,* Third Edition, 1995.

2. GSA, PBS, GSA document, *Synopsis of Project Proposals for the Year 2000,* Unpublished Internal Document, 1998-9.

3. Expert Choice, Inc., Software, *TeamEC_Platform,* Educational Edition, 1984-1997.

4. Forman, Earnst, Lecture Notes, *Executive Decision Making*, George Washington University, Spring, 1999.