

ABSTRACT

Moving Beyond the Cost Savings Paradigm – The Evaluation and Measurement of Project Performance

By

George Hunter, PE, CVS

and

Robert B. Stewart, CVS

Value Engineering has traditionally been perceived as an effective means for reducing project costs. This paradigm only addresses one part of the value equation and has typically overlooked the positive effect that VE can have on project performance for the sake of cost savings.

The California Department of Transportation (Caltrans) has developed a set of techniques for identifying key performance criteria; determining the hierarchy of importance for these criteria relative to the overall success of the project; establishing a baseline for current project performance by evaluating and rating the effectiveness of various design concepts; identifying the change in performance of VE alternative concepts; and measuring the aggregate effect of alternative concepts relative to the baseline performance as a measure of overall value improvement.

Those that are interested in getting more out of their Value programs including Value program administrators, project engineers, project managers, and other decision makers, will find this paper of interest.

OUTLINE

- A. The “Cost Savings” Paradigm
- B. The Need for Performance Measurement
- C. The Techniques
 - 1. Define Performance Criteria
 - a. Participants
 - b. Identification
 - c. Definition
 - 2. Determine Hierarchy of Performance Criteria
 - a. Performance Criteria Matrix
 - b. Development of Criteria Weights
 - 3. Measure Current Project Performance
 - a. Performance Rating Matrix
 - b. “No Build” Concepts
 - c. Alternative Design Concepts
 - 4. The Use of Performance Criteria during Alternative Concept Development
 - a. Performance Visibility
 - b. Performance Measures
 - 5. Measure Performance of Value Alternatives
 - a. Performance Rating Matrix
 - b. Net Change in Value
 - 6. Auditing and Validating Performance Measures
- D. Summary and Conclusion

Techniques of for Measuring Performance

The technique developed to measure the performance of Caltrans projects, as well as alternative concepts developed during the course of a Value Engineering (VE) study, includes the following steps:

- ◆ Define Criteria
- ◆ Determine Hierarchy
- ◆ Establish Baseline
- ◆ Evaluate Alternatives
- ◆ Compare Concepts

A complete discussion of each of these steps is provided in the following paragraphs.

Define Criteria

The first step in the process is to identify the criteria that will be used to measure the performance of the project. This is best accomplished using a team approach that includes representation from the project management staff, design team, and other project stakeholders as well as the VE team. The VE team's facilitator should moderate this session and actively encourage the participation of all team members. The facilitator should address the aforementioned entities in turn, asking each to identify what they feel to be the project's primary objectives and requirements. The facilitator should record each of these where they are visible to the group (such as on a large flip chart) as they are presented. When the group is satisfied that they have developed a comprehensive list, the facilitator should then ask the group which of them are essential to the project's overall success. Many of the items on the list can then be consolidated, or even eliminated. It is advisable to limit the criteria to no more than eight. Each of these should then be given a formal definition that everyone can refer to during subsequent evaluations. While having more than eight criteria is certainly feasible, it tends to make the process more cumbersome to facilitate. These remaining criteria should provide a well rounded "yard stick" for measuring how well a concept meets the project's objectives and requirements. They will be referred to as the project's "performance criteria."

Example

A highway improvement project proposing the widening of the mainline and the replacement of an interchange might include the following performance criteria:

- ◆ Traffic Operations – How does the concept rate with regard to the project's overall design speeds and level of service?
- ◆ Local Access – How does the concept rate with regard to access between the main line and local arterials?
- ◆ Project Schedule – How does the concept rate with regard to the overall project schedule including design and construction?
- ◆ Compliance with Design Standards – How does the concept rate with regard to its compliance with established highway design standards?
- ◆ Construction Impacts – How does the concept rate with regard to noise, vibration, dust, detours and traffic delays during construction?
- ◆ Environmental Impacts – How does the concept rate with regard to its effect on the environment including wetlands and wildlife?

Determine Hierarchy

Once the group has agreed upon the project’s performance criteria, the next step is to determine their relative importance in relation to each other. This is accomplished through the use of an evaluative tool termed in this paper as the “Performance Criteria Matrix.” This matrix compares the performance criteria in pairs, asking the question: “Which one is more important to the project?” A letter code (e.g., “a”) is entered into the matrix for each pair, identifying which of the two is more important. If a pair of criteria is considered to be of essentially equal importance, both letters (e.g., “a/b”) are entered into the appropriate box. This, however, should be discouraged as it has been found that in practice a tie usually indicates that the pairs have not been adequately discussed. When all pairs are discussed, the numbers of “votes” for each are tallied and percentages (which will be used as weighted multipliers later in the process) are calculated. It is not uncommon for one of the criterion to not receive any “votes.” If this occurs, the criterion is given a token “vote”, as it made the list in the first place and should be given some degree of importance.

It is important for the facilitator to remind the group that as they evaluate each pair of criteria, they should think of performance trade-offs in hypothetical terms. For instance, the facilitator might state: “If we were considering a concept that would improve traffic operations, but at the expense of causing greater environmental impacts, which criterion would take the priority?” The team should also be reminded that these performance criteria will be used to evaluate the merits of alternative concepts generated during the course of the VA study. As such, the group should keep an open mind and base their evaluation on what is possible rather than what exists in terms of the current design concept.

Performance Criteria Matrix

Criteria	A	B	C	D	E	F	G	H	TOTAL	%
A.	A									
B.		B			2				3	4
C.			C							
D.	1			D						
E.					E					
F.						F				
G.							G			
H.								H		

1. **List Criteria** – List the candidate criteria in the left part of the form; assign designators (A, B, C).
2. **Discuss Pairs** – Compare criterion A with criterion B asking, “Which is more important to the project?” Enter “a” in the intersecting box (next to the A designator and above the B designator). Continue for all pairs until matrix is completed.
3. **Total Scores** – Add the number of times each criterion was selected. Half scores (0.5) result from ties, where criteria are judged to be of equal importance.
4. **Normalize Scores** – Calculate percentages for each criterion, rounding off as needed.

Example

The group uses the Performance Criteria Matrix to evaluate the six performance criteria they will use to evaluate the current design concepts as well as alternative design concepts developed during the VA study.

Performance Criteria Matrix – Highway Improvement Project

Criteria	A	B	C	D	E	F	TOTAL	%
A. Traffic Operations	A	a	a	a	a	a	5	31
B. Local Access		B	b	b	b	b	4	25
C. Project Schedule			C	d	e	f	0(1)	6
D. Compliance with Design Standards				D	d	f	2	13
E. Construction Impacts					E	f	1	6
F. Environmental Impacts						F	3	19
							16	100

Note: The “Project Schedule” criterion did not receive any “votes”, however, it was given a token vote as it made the initial list.

Establish Baseline

The next step in the process is to evaluate how well the original design concept(s) are addressing the performance criteria. This step establishes a “baseline” to which the VE alternative concepts can be compared against. The Performance Rating Matrix is used to assist the VE team in determining the performance ratings for the various design concepts.

The VE team leader should first ask the group to establish the performance of the existing, or “no build”, condition. The performance criteria, and their relative weights, are first entered into the matrix. Next, the group should identify the unit of measurement for each of the performance criteria. If possible, the units of measurement should be quantifiable, however, this is not always possible or practical. Criteria such as *Project Schedule* and *Traffic Operations* are quantifiable and might use *months* or *level of service (LOS)* as units of measure. Criteria such as *Environmental Impacts* or *Construction Impacts* might use qualitative measures as they are criteria that typically involve a number of smaller factors that have been grouped together. Other possible criteria may be wholly subjective.

In any case, it is generally advisable to first evaluate the “no build” condition in order to establish a relative baseline for evaluating the current design concept. The next step is to begin assigning a 1 to 10 rating for each of the criteria, with a 1 being low and 10 high. Rating parameters should also be identified whenever quantifiable measures are used. These associate specific measures to the 1 to 10 ratings.

Once the ratings for the various criteria have been established, their total performance should be calculated by multiplying the criteria’s weight by its rating. Once the total performance for each of criteria has been determined, the concept’s total performance can be calculated by adding all of the scores for the criteria. The concept’s total performance will be somewhere between 100 and 1,000 points. A concept scoring 1000 would represent a hypothetically “perfect” concept, with all performance criteria being addressed to their theoretical maximum.

Performance Rating Matrix

Criteria	Unit of Measurement	Criteria Weight	Concept	Performance Rating										Total Performance	
				1	2	3	4	5	6	7	8	9	10		
①	②	③	④					⑤							⑥

Rating Parameters

Criteria	Unit of Measurement	low	Rating								high	
		1	2	3	4	5	6	7	8	9	10	
		⑦										

1. **Criteria** – Project-specific criteria developed on the Performance Criteria Matrix.
2. **Unit of Measurement** – “Degree of Impact” on other quantitative measures (e.g., accidents, schedule days)
3. **Criteria Weight** – Percentage weight developed on the Performance Criteria Matrix.
4. **Concept** – No build, original design(s).
5. **Performance Rating** – Selected rating on a scale of 1 (low) to 10 (high).
6. **Total Performance** – Arithmetic product of criteria weight and performance rating.
7. **Rating Parameters** – A correlation of quantifiable performance criteria to the performance rating (1 to 10). It is only necessary to list those performance criteria that are quantifiable; subjective parameters need not be identified.

Example

Performance Rating Matrix

Criteria	Unit of Measurement	Criteria Weight	Concept	Performance Rating										Total Performance			
				1	2	3	4	5	6	7	8	9	10				
Traffic Operations	Level of Service	31	No Build		2											62	
			Original Design				4										124
Local Access	Qualitative	25	No Build					5								125	
			Original Design							7							175
Project Schedule	Months	6	No Build											10		60	
			Original Design				4										24
Compliance with Design Standards	Qualitative	13	No Build				4									52	
			Original Design								8						104
Construction Impacts	Qualitative	6	No Build											10		60	
			Original Design					5									30
Environmental Impacts	Qualitative	19	No Build										8			152	
			Original Design						6								114

Performance Parameters

Criteria	Unit of Measurement	Rating									
		low	1	2	3	4	5	6	7	8	9
Traffic Operations	Level of Service	F-2	F	E	D		C		B		A
Project Schedule	Months – Design/Construction	48	44	40	36	32	28	24	20	16	10

Note: The total performance for the “no build” concept is 511 while the total for the Original Design concept is 571. This would indicate that the Original Design concept provides a +12% improvement in performance.

Evaluate Alternatives

Once the performance baseline has been established for the original design concept it can be used to help the VE team develop performance ratings for individual VE alternative concepts as they are developed during the course of the VE study. The Performance Measures form is used to capture this information as alternative concepts are developed. This form allows a side-by-side comparison of the original design and VE alternative concepts to be performed.

It is important to consider the alternative concept’s impact on the entire project, rather than on discrete components, when developing performance ratings for the alternative concept

Performance Measures Form

VE ALTERNATIVE TITLE:			
CRITERIA	Performance	Original	Alternative
	Measure		
	Rating		
	Weight		
	Contribution		
①	Measure		
	Rating		②
	Weight		
	Contribution		
	Measure		
	Rating		
	Weight		
	Contribution		
<i>Total Performance:</i>			
Net Change in Performance:			④

1. **Project Specific Criteria** – Criteria derived from the Performance Criteria Matrix; comments compare the alternative concept with the original concept for each criterion:
2. **Performance** – Three parameters defining the contribution for both the original and alternative concepts:
 - a. **Measure** – Units of measure (e.g., days) or degree (of impact) for each criterion
 - b. **Rating** – Rating on a scale of 1 to 10 for each criterion
 - c. **Weight** – Weight for each criterion derived from Evaluative Criteria Matrix
 - d. **Contribution** – Arithmetic product of rating times weight for each criterion
3. **Total Performance** – Arithmetic sum of contributions for all criteria for both original and alternative concepts
4. **Net Change in Performance** – Percentage change of alternative total performance measures with original total performance measures taken as 100% performance (+% = increased performance for the alternative; -% = reduced performance).

Example

Performance Measures Form

VE ALTERNATIVE TITLE: Shift Highway Alignment West			
CRITERIA	Performance	Original	Alternative
Traffic Operations – No change.	Measure	LOS	LOS
	Rating	4	4
	Weight	31	31
	Contribution	124	124
Local Access – Provides improved access by tying Broadway Blvd. directly into the interchange.	Measure	Qualitative	Qualitative
	Rating	7	8
	Weight	25	25
	Contribution	175	200
Project Schedule – No change.	Measure	Months	Months
	Rating	4	4
	Weight	6	6
	Contribution	24	24
Compliance with Design Standards – No change.	Measure	Qualitative	Qualitative
	Rating	8	8
	Weight	13	13
	Contribution	104	104
Construction Impacts – Significantly reduces traffic delays during construction by eliminating detours on Broadway Blvd. and simplifies construction of the new overcrossing.	Measure	Qualitative	Qualitative
	Rating	5	7
	Weight	6	6
	Contribution	30	42
Environmental Impacts – Reduces impacts to wetlands.	Measure	Qualitative	Qualitative
	Rating	6	7
	Weight	19	19
	Contribution	114	133
<i>Total Performance:</i>		571	627
Net Change in Performance:			+10%

Compare Concepts

The last step in the process completes the Performance Rating Matrix that was initially begun to develop the performance ratings for the original design concept. The performance ratings developed for the VE alternative concepts are entered into the matrix and the summary portion of the Performance Rating Matrix is completed. The summary provides details on net changes to cost, performance and value.

Performance Rating Matrix – Overall Performance

Concept	Total Performance	Total Cost	Value Index (P/C)	% Value Improvement
Original Design Concept				
	1	2	3	4

1. **Total Performance** – Arithmetic sum of total performance for each VE alternative concept
2. **Total Cost** – Estimated cost for each VE alternative concept (\$ million). The cost figure should be expressed with the base number to 3 places in front of the decimal point. For example, \$145,562,000 should be expressed as 145.5 in order to have a value ratio in the magnitude of 1 to 10
3. **Value Index** – Arithmetic division of total performance by cost. The value will be between 1 and 10 with two decimal places.
4. **Percent Value Improvement** – Net increase (+) or decrease (-) of value index in percent

Example

Performance Rating Matrix – Overall Performance

Concept	Total Performance	Total Cost (\$ millions)	Value Index (P/C)	% Value Improvement
Original Design Concept	571	37.0	15.4	
VE Alternative Concept #1	627	35.0	17.9	+48%
VE Alternative Concept #2	531	34.0	15.6	+1%
VE Alternative Concept #3	580	39.0	14.9	-3%

Note: This example demonstrates the importance of using both cost and performance in evaluating the potential benefits of alternative concepts developed during the course of a VE study. Without performing this analysis, it may be unclear to decision makers if VE Alternative Concepts 2 and 3 offer improved value.

BIOGRAPHY
GEORGE HUNTER, P.E., CVS

George Hunter has been in charge of the Value Analysis Program for California Department of Transportation (Caltrans) since 1995. This program provides improvements in quality, performance and costs on its projects and processes. In the last three years the program has completed 91 project studies, reducing projects originally costing \$7.3 Billion by \$478 million.

Prior to his position as Value Analysis Branch Chief, George was the Project Engineer on the Cypress Replacement Project, a \$1 Billion project that replaced a four-mile earthquake damaged portion of I-880 in the San Francisco Bay area that linking San Francisco, Oakland and Sacramento.

George's career has also includes six years with private consulting firms in California, Illinois and Massachusetts in the transportation and mining fields.

Credentials:

- ◆ Bachelor of Science- Civil Engineering, California State University- Sacramento, 1984
- ◆ Professional Registered Engineer- California
- ◆ Certified Value Specialist- SAVE International (Society of American Value Engineers)
- ◆ AASHTO Value Engineering Task Force (Representative for State of California)
- ◆ Regional Director for Brazil, SAVE International

BIOGRAPHY
ROBERT B. STEWART, CVS

Mr. Stewart is a professional Value Engineering consultant and is Vice President of Value Management Strategies, Inc.'s operations in the Pacific Northwest. In addition, he is an Adjunct Professor teaching Value Engineering at Portland State University.

Mr. Stewart has participated in more than 100 VE studies as both facilitator and project manager, for a wide range of projects. He has lead numerous VE studies for highway and transit projects, including, most recently, the \$1+ billion East Span Replacement Project for the San Francisco/Oakland Bay Bridge. He has been an instructor in many SAVE approved Module I VE Training Workshops sponsored by a variety of educational institutions, government agencies, and private companies.

Credentials:

- ◆ Bachelor of Arts – Geography, University of Oregon - Eugene, 1990
- ◆ Adjunct Professor, Department of Civil Engineering, Portland State University
- ◆ Certified Value Specialist, SAVE International No. 920601
- ◆ President, Portland Chapter, SAVE International