Value Engineering Analysis of Selected Maintenance Activities

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A series of value engineering studies of selected road maintenance activities was initiated by the Federal Highway Administration to demonstrate that value engineering techniques could be successfully applied to maintenance activities and to improve these activities. Because the value engineering process uses the team approach, teams of state engineers were formed to conduct the studies. Each study involved teams of two or three engineers from four states. The work was coordinated by the Federal Highway Administration at four joint meetings held during the course of the project. A summary report has been prepared for each study. Five studies have been completed, and five more are under way. The total cost of the five completed studies was $432 000 with an estimated savings of more than $7 million among only the states involved. Based solely on the cost savings, it has been shown that the value engineering process can be successfully used to perform an in-depth analysis of maintenance activities. Other, less tangible benefits have also been realized.

The cost of maintaining the highway system is increasing at a yearly rate of approximately $300 million. It is thus imperative that each dollar spent return the maximum service benefit. Research and development efforts in the maintenance area have the potential for improving the quality of service and increasing the quantity of maintenance activities.

The Federal Highway Administration (FHWA), recognizing that research in the maintenance area has often been fragmented and that large future expenditures for maintenance are expected, entered into a contract with the Transportation Research Board to develop a recommended national highway maintenance research program. This study identified 28 high-priority maintenance research projects.

The highest priority research project listed was optimizing the expenditure of maintenance resources. The objective of this project was to analyze high-cost maintenance activities and identify the best method or methods for accomplishing these activities. To attack this problem, the implementation division of FHWA elected to apply the techniques of value engineering to the analysis of selected maintenance activities.

SCOPE

This project consists of 10 separate studies conducted by various state highway agencies under the coordination and guidance of FHWA. The studies include the following maintenance activities: snow and ice control (materials), snow and ice control (operations), shoulder maintenance, bituminous patching, repair of continuously reinforced concrete pavement (CRCP), sign maintenance, bridge painting, pavement markings, repair of pavement joints, and maintenance of rest areas.

A total of 26 state highway agencies have participated in nine of the studies. The study of rest area maintenance was scheduled for early 1978 and will involve 3 or 4 additional states.

PROCEDURE

Value engineering is defined by the Society of American Value Engineers as a systematic application of recognized techniques that identify the function of a product or service, establish a value for that function, and reliably provide the necessary function at the lowest overall cost.

The value engineering job plan consists of nine phases:

1. Selection,
2. Investigation,
3. Analysis,
4. Speculation,
5. Evaluation,
6. Development,
7. Presentation,
8. Implementation, and
9. Audit.

The process involves dividing an activity into its functions, establishing costs for these functions, selecting the high-cost functions, speculating on alternatives that will serve the same function, and evaluating the most promising alternatives.

For example, in the repair of CRCP, 12 functions could be developed. The next step would be to establish costs for these functions. The average cost in one state for the repair of CRCP is $169.18/m^3 ($128.58/yd^3). The cost breakdown by functions is given below (1 m^3 = 1.3 yd^3):

Function	Cost/m^3 ($)	Function	Cost/m^3 ($)
Locate area	0	Restore base	0.26
Load material	6.04	Replace steel	13.37
Travel to work area	5.40	Place, consolidate, and finish concrete	29.57
Set up signs	6.43		
Mark area	0.26	Place curing compound	1.03
Saw concrete	6.81	Take down signs	3.22
Break out slab	56.19	Total	128.58

Three items account for about 77 percent of the costs involved in this activity. These functions would be the ones to concentrate on in the speculation phase. The speculation phase makes use of the brainstorming technique to produce the greatest number of alternative ideas for later evaluation and development. At this stage, all ideas—no matter how wild they may seem—are listed. The point is not to stymie free thinking by evaluating ideas.

Evaluation is the next step. Among the techniques available for evaluating alternative ideas are advantages versus disadvantages, ranking techniques, checklist techniques, and probability of success. It is necessary to establish costs and weigh the alternatives.

The development phase provides for further development of the most promising alternatives selected during the evaluation phase. The intent is to obtain more adequate backup data on design and costs so that recommendations for a change may be presented to management. An implementation plan should also be developed.

The presentation, implementation, and audit phases provide a means for putting the recommendations into concrete terms and a check to ensure that the desired results have been attained.

Since execution of the value engineering plan requires a team approach, each of the states has been requested to provide a two- or three-person team. The contract duration is 6 months, but the actual number of weeks worked by the individual team members has amounted to considerably less and has not severely hampered them in the performance of their normal duties.

During the 6-month period, four organization and coordination meetings are held. The first meeting, which is an orientation session, includes a discussion of value engineering techniques, study limits, terminology, and meeting schedules. Between the first and second meetings the states work individually on the investigation and analysis phases of the job plan. The speculation and evaluation phases are conducted between the second and third meetings, and before the last meeting the development and presentation phases are completed. At each of the meetings the states present the work they have completed since the last meeting. This results in an exchange of ideas between the states and provides for overall guidance and coordination for the study.

At the conclusion of the study, each state prepares a report on its findings and recommendations. These reports are combined into one report that is printed and distributed by FHWA.

The studies and the states that have been involved in them are given in Table 1.

SUMMARY OF RESULTS

Only the first three studies given in Table 1 have been completed and their reports published. The studies on bituminous patching, repair of CRCP, and sign maintenance are essentially complete, and the final reports are being prepared. The remaining four studies are just getting started or will be under way shortly. Therefore, this summary is limited to the results of the three published studies.

Snow and Ice Control (Materials)

1. Specifications for abrasive materials should be as lax as possible.
2. Material for snow and ice control should be purchased in large quantities from central sources.
3. Chemical additives should be mixed into the abrasives by the supplier.
4. Properly mixed, free-draining materials do not need to be dried or stored outside.

Snow and Ice Control (Operations)

1. Application rates for salt and abrasives should seldom exceed 142 and 421 kg/two-lane km (500 and 1500 lb/two-lane mile) respectively.
2. Processed salt costs less and is as effective as kiln-dried salt.
3. When it is applied properly under suitable conditions, straight salt can be as effective as and less expensive than abrasives or a mixture of salt and abrasives.
4. The use of ground control spreaders can save time, material, and fuel.
5. The use of carbide inserts on snowplows will substantially reduce the costs of operations that currently use carbon steel blades.
6. The use of single-purpose equipment should be thoroughly analyzed and questioned.
7. Under certain conditions, renting equipment with operators can reduce operating costs.
8. Calibration of spreaders is essential regardless of the type of spreader and material.

Shoulder Maintenance

1. In shoulder shaping with adding material, (a) add an auxiliary blade behind the moldboard of the grader, (b) add a wing plate to the grader blade, (c) operate the motor grader and the truck-mounted blade in tandem, (d) permanently relocate delineator posts, and (e) use a light-duty maintenance device rather than a grader for light reshaping.
2. In shoulder reshaping with material added, (a) increase the size of haul trucks, (b) where applicable require truck drivers to load their own trucks at the stockpile, (c) improve the locations and management of stockpiles, (d) deposit and shape the material in one operation by using a side delivery spreader, and (e) use bottom dump semitrailers to place material directly on the area.
3. At locations where frequent edge repair is needed, reduce or eliminate dropoff maintenance by spot paving the area.

PROJECTED COST SAVINGS

The costs and savings that would result in the involved states from the implementation of study recommendations are summarized below:

Study	Cost ($000)	Annual Savings ($000)
Snow and ice control (materials)	60	220
Snow and ice control (operations)	85	5000
Shoulder maintenance	104	1000
Bituminous patching	88	500
Repair of CRCP	95	-

The ratio of study cost to annual savings is very favorable. There is a great potential for providing improved levels of service for maintenance activities.

CONCLUSION

In the area of cost benefits alone, the results are very promising, but there is another benefit that could possibly be more valuable—that is, the opportunity for maintenance engineers from various states to meet and discuss mutual problems and share information. The state engineers have picked up ideas on elements such as equipment modification, revisions to their maintenance management systems, equipment needs and types of equipment, and maintenance facilities. In addition, managers have taken the time to stop and take a long look at what is going on in these activities.

In view of rising costs and limited revenues, it is essential that every effort be made to optimize the ex-

Table 1. States performing value engineering studies.

Study	State
Snow and ice control (materials)	Colorado, Montana, Utah, Wyoming
Snow and ice control (operations)	California, Colorado, Utah, Pennsylvania
Shoulder maintenance	Idaho, Arizona, Iowa, West Virginia
Bituminous patching	Oregon, Utah, Pennsylvania, Arkansas
Repair of CRCP	Texas, Louisiana, Arkansas, Mississippi
Sign maintenance	Florida, Arkansas, Kentucky
Bridge painting	New Jersey, New York, Wisconsin
Pavement markings	Florida, Illinois, North Carolina, New Mexico
Repair of pavement joints	Kansas, Iowa, Nebraska, South Dakota
Maintenance of rest areas	States not yet finalized

penditure of maintenance dollars. We believe it is imperative that each highway agency make use of the applicable recommendations from other state studies. Whether you call it value engineering or productivity management, each state highway agency, either on its own or preferably in conjunction with two or three other agencies, should conduct an in-depth analysis of its maintenance activities.

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Development of a Computerized System for Pavement Maintenance Management

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This paper describes the development of a computerized system called PAVER for use in the management of pavement maintenance and repair. Included are problems encountered in developing PAVER, characteristics of a successful computerized system determined through experience gained from field tests, system description and user procedures, and a discussion of system benefits and initiation and operation costs.

In recent years, the rapid growth of new pavement construction has leveled off, and emphasis has been placed on maintaining existing pavements. Choosing the maintenance and repair alternative that will provide the desired level of pavement performance and be most cost-effective in the long run is a difficult task. It requires consideration of data that describe distress in existing pavement, rate of pavement deterioration, and pavement load-carrying capacity. Even if this information is available, it is often too time consuming to compile and analyze it for each section of pavement in a large pavement network that requires repair. Consequently, it is estimated that millions of dollars are wasted each year in the United States as a result of uninformed pavement repair decisions.

In the age of computerization, the logical solution seems to be the development of a computerized pavement maintenance management system. Such a system has been developed at the U.S. Army Construction Engineering Research Laboratory (CERL). The system, called PAVER, consists of a method for inspecting and evaluating the condition of a pavement; a data base for storing relevant pavement information; simplified methods of data input, update, and retrieval; and an economic analysis program to aid in selection of repair methods. PAVER is operated by the pavement engineer on a desk-size, typewriterlike computer terminal and small card reader that transmit and receive data from the computer over telephone lines.

This paper discusses the problems encountered in the development of PAVER and describes the resulting system, which is a product of 5 years of development, field testing, and efforts to respond to the needs of the field pavement engineer.

SYSTEM DEVELOPMENT

Initial Computerized System

It was decided at the onset of the project to use a generalized data base management system to construct the PAVER data base, the advantage being that a data management system provides built-in capabilities for alteration of the data structure and updating and retrieval of information. The data management system selected was SYSTEM 2000 (1). Within SYSTEM 2000, data are stored in "data elements"; each data element has a name that describes the kind of data stored in it. Related data elements are organized into "repeating" groups.

Once the data management system was selected, the data elements had to be defined and organized into a data structure. The result was the data structure shown in Figure 1. The boxes represent groups of data elements (repeating groups).

This initial data structure was tested by collecting data at one installation. It was found that only a very small subset of the data could actually be collected. In addition, both data storage and retrieval were prohibitively expensive. The decision was made to limit the data base design to only those data elements that would be used in the next 10 years. To prevent repeated revisions of the data base definition, it was decided that the technology of pavement management would be developed and manually tested and then, based on the field test results from the manual system, data elements would be defined and a computerized system developed.

Manual System

After several iterations of field testing and revision, a manual pavement maintenance system was developed. The system consists of the following main activities, which are summarized in the flow chart shown in Figure 2.