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THE APPLICATION OF VALUE ENGINEERING TO HIGHWAY PROJECTS AND PROGRAMS

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Abstract - *A big challenge to all highway agencies is to face the needs exceeding the funds made available to them. In developing nations, like India, the imbalance of required funds and available funds results into an inability to maintain and upgrade existing highways or construct new highways. In a developed nation, this imbalance may affect the maintenance and expansion of an existing highway network.*

Large budget is allocated to Highway programs even in the poor nations. Highway resources are generally considered as limitless. But, every highway authority is completely aware of the resources available to their program are finite. To keep highway project and program costs within available funding, they are frequently forced to eliminate or drastically reduce the scope of projects or entire programs.

There is an alternative, to control the expenditures by effective means of identifying unneeded and unwanted costs at the same time preserving the essential elements of projects. This process is known as value engineering (VE), and it has been applied efficiently for over 40 years by various industries as an engineering and management tool for cost control and increasing profit margins, while assuring that essential product functions are maintained.

Key Words: *value engineering, improve construction, highway construction*

WHAT IS VALUE ENGINEERING?

Value engineering is a systematic and organized approach for providing the necessary functions in a project at the possible lowest cost. Value engineering promotes the alternative of materials and methods with less expensive replacement, without compromising functionality. It is focuses on the functions of various components and materials, rather than their physical properties. Value engineering may also be called as value analysis.

In the highway context, products and services include the structural elements of highways as well as the processes, equipment, and supplies used in their development, from concept through operation and maintenance. The required function should be achieved at the lowest possible cost and max life-cycle as required for performance, maintenance, safety, and aesthetics.

This technique was developed by Lawrence D. Miles, a General Electric staff engineer, in 1947. VE is greatly recognized in manufacturing and industry throughout the world. But its application to public works, particularly highways, is largely limited to the United States and just recently the Republic of Indonesia till now.

The process of VE is carried out by a multi-disciplinary team of technical experts following a set of procedures referred to as the VE job plan. The job plan consists of eight phases: **Selection, Investigation, Creative, Evaluation, Development, Presentation, Close out/ Implementation.**

SELECTION PHASE:

The selection phase identifies which projects will be studied. Value engineering or value analysis is not free so careful selection of study object must be done. It should assure maximum returns on the investment of agency's resources. Projects which are good objects for VE study are ones that:

- Significantly exceeds initial cost of estimates;
- Which have complicated designs;
- High cost & critical material requirement;
- Are difficult to construct or fabricate;
- Have questionable justification;
- Have record seeking design;
- Appear too costly to build or maintain; or

An effective tool for identifying value study object is Pareto's law of distribution. Pareto's law is based upon the principle that approximately 20 percent of the elements in a construction project or program will account for about 80 percent of its total cost. An example would be a highway agency. The total cost of the 20% most expensive projects will equal about 80 % of the total cost of all the program.

INVESTIGATION PHASE:

The investigation phase is the first of five phases performed by the VE study team. It is also the foundation upon which the remainder of the study will be carried out. Three activities are performed during the investigation phase:

1) All applicable information regarding the project and its major elements is gathered;

2) The functions of the project and its major elements are determined; and

3) The cost and worth of the functions of the major elements are determined, and the functions with the greatest potential for value improvement are identified.

Function analysis is a technique which sets VE apart from other cost reduction efforts. It asks the questions, "What must this project or project element do or accomplish" and "What else does this project or project element do?" The functions can be classified as utility, aesthetic, esteem, and unwanted. In highway applications, the utility function is the most important and the aesthetic and esteem functions are secondary. The function is defined in the simple term, a verb and a noun. The basic function of a bridge is to "cross the obstacle." If it is designed to be the longest, highest, etc., structure, then the esteem function may also add the cost to the project. The heat generated by a light bulb or the disposal of excess excavation are examples of unwanted functions. Both are costly, but these do not contribute to the performance of the basic functions of the light bulb or highway.

Cost and worth are often confused, but in VE they are very distinct. Cost is the amount of money that spent to achieve a function using the present design, and worth is the minimum amount that must be expended to attain the required function. Cost will always exceed worth, but when cost substantially exceeds worth, the potential for value improvement is high. Those functions with costs substantially exceeding worth are selected for further evaluation in the VE study.

CREATIVE:

In this phase, the study team speculates on different ways of performing the functions which are having high potential for value improvement. The team applies brainstorming techniques to develop more efficient alternatives to the current project design. Brainstorming forces people to be creative. The mechanism that produces this phenomenon is called synergism --one idea triggers other ideas through similarities or like ideas.

The VE study team uses brainstorming to generate a large list of potential solutions to the problem described by the two-word function, which prepares the team to enter the next phase.

EVALUATION:

In the Evaluation Phase, the advantages and disadvantages of each remaining alternative are enlisted. Each and every advantage or disadvantage is described in general terms. The team can perform a weighted matrix analysis depending upon the need to determine which alternative is best. If the disadvantages are more than the advantages of any alternative, then that alternative is dropped from further consideration at this point.

Conducting this analysis ensures the VE objective--to achieve the best blend of performance, cost, and schedule. Perfection should not be the objective of the VE study team.

DEVELOPMENT:

Once the team made the selection of the best alternatives, they are fully prepared with sketches, cost estimates, validation of test data, and other technical work for determining if any of the assumptions made during the study or development phase are in fact valid or not. The Development Phase is the final step. Team presents its recommendations to the agency's management. The study team construct an implementation plan which describes the processes that the agency must follow to implement any recommendations.

PRESENTATION:

The final product of a VE study is the official VE Report with the presentation of the team's recommendations. In this phase, the VE team presents their findings to the project decision makers, and tries to convince them that their ideas should be adopted.

While making the presentation, the study team should take care when presenting estimated cost savings or, in some cases, increased costs associated with recommendations. Overstating or double counting savings must be avoided. For VE studies which take longer time to complete, it is always better for the study team to provide progress updates in certain intervals to the appropriate project management staff.

The VE Report serves as a step-by-step record of the work executed during the preceding phases. The report provides documentation to support the team's recommendations, tracks the team's deliberations and/or considerations, and supports in implementation of the recommendations. It can also be a useful reference tool for future projects and VE studies for similar topics.

CLOSE OUT/IMPLEMENTATION:

No recommendation for cost savings can achieve savings unless and until it has been implemented. However, it may not be possible to implement each and every recommendation proposed by team, the project decision makers must take the appropriate decision to ensure that a fair and serious consideration of the proposed recommendations have taken. Main activity of the Implementation Phase is the information sharing within the

agency as the recommendations have to be implemented on projects. Not only does this activity promote the benefits associated with conducting the VE studies but also it will provide benefit to future transportation projects.

The final phase of the Job Plan also involves determining the actual amount of savings estimated by the VE analysis. This may depend on the amount of recommendations implemented in the construction project and evaluating the outcome of the recommendation achieved in the project.

APPLYING VE TO HIGHWAY PROJECTS AND PROGRAMS:

Excellency in design is the goal of every designer. No designer would knowingly incorporate poor value into his work, but the experiences have shown that highway projects are not different than buildings, military hardware, automobiles, etc. Due to following reasons, poor value clips, in the best designer's work, commonly attributed to highway projects:

- Lack of information;
- Shortage of time;
- Habitual thinking;
- Emphasis on performance at any cost;
- Changing technology;
- Misunderstood project requirements;
- Changes in conditions or project scope over time; and
- Decisions made before the costs and/or value of alternatives are known.

As highway professionals, designer will analyse items on this list and then their influence on his projects. This is not an allegation of his ability as engineers, but a reflection of the world he must all work in. Value engineering provides a tool for the reasonable evaluation of our work and helps to preserve the design excellence for which highway engineers are so rightfully proud. VE is the early decisions taken that have the greatest influence on a project's life-cycle & cost.

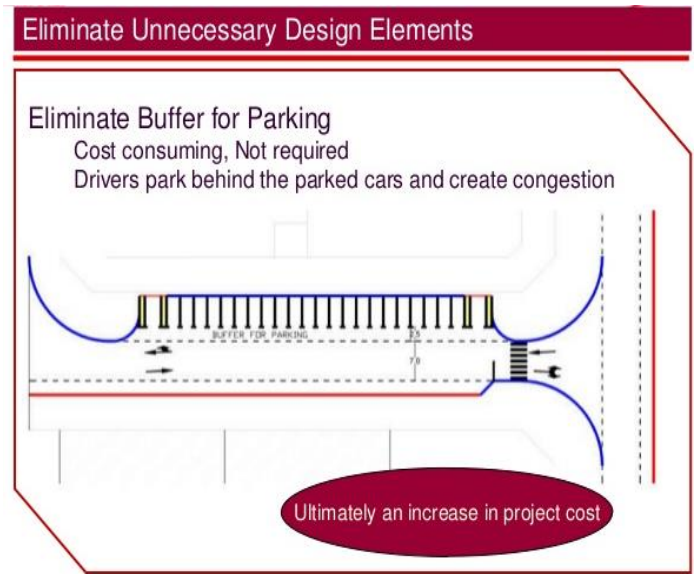
Experience has also shown that recommendations from VE studies done early in the project development process have a much better chance of acceptance than ones from studies done later. Logically, the selection of projects for VE study should occur early in the project development process so that the study can be conducted when the potential for savings and acceptance is greatest. When the design of a project has advanced to about 30 percent completion, it is quite likely ready for VE review. For large improvements requiring several construction projects to complete, two or more VE studies may be appropriate: one during early design and others as the design progresses.

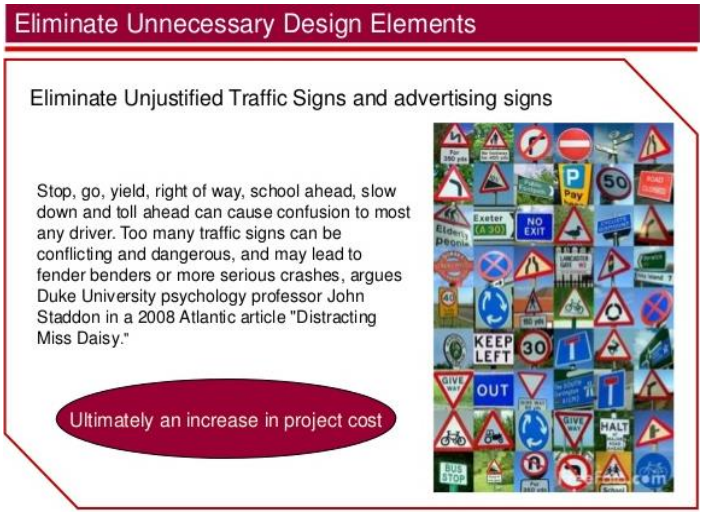
Nearly all highway projects are designed by several individual firms or small groups working independently to achieve a more or less common goal. There is frequently a lack of effective communication, and information sharing between two designers, because they are not aware of its existence; misunderstandings occur; and individual design elements are maximized without consideration for the project as a whole. The multi-disciplinary team approach used in VE can overcome these communication breakdowns. Also, working as a true team, the VE study team can generate more and better ideas than as individuals working separately. This is most clearly demonstrated during the speculation phase.

Value engineering teams are generally made up of five to eight members from various backgrounds. Areas of highway expertise that should be considered when forming a team are traffic, structures, hydraulics, right-of-way, environment, geometries, geotechnical construction, maintenance, materials cost estimating, and many others. The team members' attitudes are as important as their technical backgrounds. Members should be open-minded and willing to work in a team environment. To assure objectivity, it is recommended that none of the members have direct involvement in the project being studied. Leadership is also a critical factor in the success of the VE study. The leader must be technically competent, experienced in the value process, and have good leadership qualities.

Gathering information for the VE study in Highway projects can be a difficult task. The team must be thorough but tactful. The required information will probably be distributed to several offices as well. Some designers may be antipathetic to provide information for a variety of reasons. The level of development of VE recommendations can vary depending on the needs of the highway agency. Some develop the proposal to a point where an informed decision can be made, but additional effort will be needed to implement it. Others fully develop the idea into a nearly complete design before presentation to management. Either procedure is satisfactory as long as management knows what they are getting and the team knows what is expected of them. The real results of a VE program are not study recommendations but value actually achieved. Implementation of a VE proposal does not happen by itself. Management must accept the proposal, the approved proposal must be communicated to the designer, and the designer must incorporate the proposal into the plans. Making sure that all this happens will avoid wastage of effort.

Following are the some parts of Highway construction





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