Session 4: Value Engineering, Design and Construction
Session Chair:

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Session Highlights

- Value engineering (VE), quality control and quality assurance are close cousins. VE can result in considerable cost savings with no loss in QC/QA.
- Value engineering is comprehensive and includes the design, construction and procurement of major transit investments. The savings resultant from value engineering are frequently many times the costs of the value engineering studies.
- Turnkey contracting can be a form of value engineering. Requirements for value engineering studies in transit turnkey projects are subject questions concerning the necessity in the context of the prevailing incentives.
- The considerable cost savings generated by value engineering is typically shared between the owner and the contractors. Contractors are generally not rewarded for value engineering savings they identify in their work.
- The incentive for value engineering in the design phase of conventional and turnkey projects are not certain. There must be incentives for the designer to engage in value engineering.
- Value engineering in the context of turnkey is still evolving. Just as turnkey is many different approaches with no single established practice, value engineering will have to adjust to the requirements, opportunities, incentives and constraints resulting from turnkey approach and procurement.

Thomas J. Luglio, Jr. , P.E.
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Mr. Luglio reviewed his resource paper ("Value Engineering, Design and Construction") which addresses value engineering (VE) in both a project's design and construction phases; quality assurance (QA) and quality control (QC) as applicable to support design, construction, manufacturing, and testing functions; and the degree of contractor implementation freedom permitted. These are considered from the perspective of both conventional and variations of turnkey implementation approaches.

VE is a process of attempting to obtain the essential function of an improvement at the lowest life cycle cost by refining its design and encouraging efficient construction. Given that the turnkey contractor is responsible for both design and construction, certain incentives will exist to achieve value engineering efficiencies, and the degree to which value engineering still has a role in these contracts is considered.

QA and QC are elements of a quality system which encompasses the organizational structure, responsibilities, procedures, processes, and resources for implementing quality management. Quality in a project management sense is on a footing with cost and schedule control.

There are two basic aspects of value engineering, related to design and construction, respectively. During the design stage an independent team specializing in value engineering is utilized to conduct a value engineering study. The construction value engineering includes phases for implementation, speculation, analysis, development and, presentation. During the construction stage, contractors can be permitted to offer value engineering change proposals (VECPs). If deemed worthwhile because of their cost savings, the value engineering change proposals can result in monetary benefits which are shared between the owner and the contractor.

The speaker reviewed the FTA requirements and guidance of value engineering and QA/QC. These are formulated for the conventional (design-bid-build) implementation approach. value engineering studies are generally conducted at or near the end of preliminary engineering (PE). For some large complex projects a second value engineering may be advantageous, with the second value engineering conducted at 60 to 75 percent completion. Other design refinement techniques (e.g., peer review; design reviews; agency/community outreach, industry reviews and pre-bid meetings) were considered. Mr. Luglio noted that as part of the Turnkey Demonstration Program, FTA made teams of experts familiar with turnkey projects and concepts available to grantees to review the grantee's approach and for the discussion of related issues.

The speaker observed that while it has become accepted practice for construction contractors to be responsible for QC functions, the owner maintains responsibility for QA functions, possibly supported by a construction management (CM) consultant. The owner should have a detailed QA/QC Plan to guide their QA activities and define contractor responsibilities. The FTA Turnkey Demonstration projects are consistent in assigning QA and QC responsibilities to the contractor, including the construction management function usually performed by the owner on conventional contracts. The contractor must prepare the Quality Program Plan for the owner's approval. The owner's role becomes one of quality oversight.

Mr. Luglio closed with the following observations and recommendations:

- Value engineering during the design stage has proven to be a valuable tool in identifying potential cost savings. The cost savings of the accepted proposals typically exceed greatly the cost of performing the value engineering study.
- Value engineering studies should be conducted towards the end of the preliminary engineering, with sufficient time to consider proposed changes and to incorporate them into the turnkey procurement package.
- A contractor has inherent incentives (and disincentives) based on the scope and extent of the turnkey contract and the nature of the pricing. The owner only benefits from the contractor's incentives to the degree the contractor's costs to the owner are reduced. It is imperative that a high degree of competition be achieved when procuring turnkey contracts, either through competitive negotiation (RFP and evaluation of proposals) or formally advertised (IFB and low bid award).
- Turnkey contractors have greater opportunity for creativity when working on an entirely new transit system. For a new system the owner can provide more of a performance specification to which the contractor develops the detailed designs.
- For extensions to existing systems, the owner must constrain the turnkey contractor by providing very detailed designs and specifications. This limits the contractor's ability to achieve cost savings through innovative designs.
- The turnkey contractor should not be rewarded for recommending a value engineering change proposal on its own design. Value engineering change proposals must be limited to proposals challenging the owner provided baseline designs, standards and specifications.
- Grantees who permit value engineering change proposals provide rigid requirements for the submission of contractor proposals.
- Since the owner must continue to perform some construction management functions in support of verification activities, including construction progress and contractor payments, it is possible that the total cost of quality activities may not be reduced on turnkey contracts.
- The public nature of transit projects limits turnkey transit projects in their freedom to independently advance implementation activities. Good planning on the owner's part should result in giving as much freedom as possible to contractors to achieve the owner's time, cost, and other project objectives motivated by profit.

Alex P. Goff
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Mr. Goff noted that the terms and concepts of value engineering, value analysis and value management were interchangeable. They refer to the systematic process of adding value. The role of the Society of Value Engineering (SAVE) in recognizing Certified Value Engineering Specialist was considered as well as the history of the value engineering process. The role of federal agencies, including the FTA, in requiring value engineering for major investment projects was commented on.

The speaker emphasized that value engineering teams must be independent of the design team. Value engineering should take a fresh and unconstrained analysis of design requirements and solutions. In conventional projects, value engineering should be undertaken at the 30 percent design stage, while for design-build turnkey projects, value engineering should be undertaken as early as possible.

Several case studies were cited associated with the San Francisco Bay Area Rapid Transit (BART) system. In the first case study of a value engineering analysis of a ticket vending machine acquisition, the original vending machine specification was changed to utilize privately provided bank style ATM machines to dispense high value tickets. This resulted in a $5 million cost savings and greatly improved customer service. In the second case study of a train control system for two new lines, the initial decision to specify the existing train control system was replaced with a performance based specification where one performance standard was compatibility with the existing train control system. Approximately $2.5 million in cost savings resulted. Other benefits included increased safety and increased capacity due to decreased headway.

Several other BART case studies were referenced where for a total study cost of $125,000 the owner experienced a total cost savings of $17.5 million. Overall the savings to cost ratios on the cited projects ranged from 25-to-1 to 158-to-1.

Value engineering is most applicable to high cost, high technology type items and safety considerations. Operations, systems, communications, civil, structural, financing plan, maintenance and route alignment are among the other promising areas for the application of value engineering.

Frank Waesche III, P.E.
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Mr. Waesche discussed value engineering in the context of

the MTA's conventional and turnkey projects. Typically value engineering is executed at the 30 percent stage of conventional major capital projects. An example of value engineering in a conventional project is the $300 million, 1.5 mile, two-station subway extension project. In this instance value engineering led to a reconsideration of assumptions regarding the community acceptance of the construction staging for the subway tunnel. This resulted in a revised construction staging and a $4 million saving to the project. Overall on the project 38 value engineering proposals, resulted in 32 VECP's and $14 million in savings to the project. The MTA shared these savings with the contractor.

The Baltimore LRT extension is design-build and one of the FTA Turnkey Demonstration Projects. The civil design was approximately 30 percent complete and the systems engineering was 80 percent complete at the implementation of the turnkey procurement. MTA considered the turnkey as value engineering and sought and received a waiver from the FTA concerning its (FTA's) value engineering guidelines. MTA pro-actively accepted contractor initiated value engineering cost savings as an incentive for the contractor to produce the project within the specifications (i.e., time and costs) advertised by the owner. In course, the turnkey contractor developed a $300,000 cost savings on civil works that benefited the contractor. Correspondingly, the MTA's position is if the turnkey contractor experiences an unfavorable cost element, the adverse costs will be borne by the contractor.

In summation, Mr. Waesche observed:

- The purpose of design-build methodology is for the Owner to assign responsibility for proper delivery to a single business entity. The goals of design-build are to speed project delivery, reduce costs and encourage innovation.
- Value engineering is not appropriate in design-build projects because the Owner has selected a contracting methodology that encourages innovation. If VE is included, it seems that the Owner then tries to take undue economic advantage by insisting on sharing the cost savings generated by the design-build team.
- If VE is included in design-build, does it mean that the Owner is responsible for additional costs if his concept plans or preliminary plans do not work? Including VE in design-build is suggestive of traditional design-bid-build.
- Design build is a fast-track contracting technology. In the time required to analyze a VE proposal the design-build contractor would be forced to withdraw the VE effort to keep the project on schedule.

Frank Turpin
Vice President
Bechtel Infrastructure
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Mr. Turpin's presentation focused on issues affecting the price of turnkey projects. Turnkey projects were noted to vary, with few projects sharing the same approaches. Four issues that affect the price of turnkey projects were focused on for consideration: structuring the team, the preliminary engineering basis of the bid, owner provided design, and the value engineering process internal to the contracting team.

The nature of turnkey projects requires the formation of teams consisting of civil design, vehicle manufacture, and operations and maintenance specialties. The specialties have different interests which must be reconciled. Where there are uncertainties, contingencies or contract exceptions result. The nature of teaming limits the competition to a few companies (teams) and this can lead to higher prices. An owner-industry review process is critical. This review process encourages discussions between the owner and the contracting team resulting in confidence building within the contracting team and between the owner and the contracting team.

The design basis provided to the contractor for bidding purposes is a second area of concern. The design basis takes the form of a performance based specification or a preliminary engineering package for bid. FTA generally encourages advanced preliminary engineering but many transit agencies can not warrant the preliminary engineering validity. The turnkey contractor can either repeat the preliminary engineering or accept the owner preliminary engineering basis and accept the risk of errors and claims. Accepting the performance specification leads to errors in interpretation and the high cost of bidding. Neither of these options is acceptable. A middle ground between preliminary engineering and performance specifications is recommended for consideration.

A third consideration is aspects of a turnkey project for which the owner provides a completed design. This is characteristic of extensions of existing systems or where the owner has a preferred mitigation approach. Several BART examples were referenced. These areas are promising for the application of value engineering. Value engineering is important relative to the turnkey contractor's ability to reduce costs. The owners unwillingness to accept value engineering changes to completed design assumptions can result in added costs.

Value engineering internal to the turnkey team is important relative to the ability of the team to reduce costs. Value engineering in a turnkey project will focus the design consultant. In a conventional project, the design consultant has no incentive to engage in value engineering except to the degree that it affects the design consultants reimbursable costs. In turnkey projects, Bechtel is considering returning a portion of the value engineering saving to the design consultant. The return to the design consultant must be adequate to provide an incentive for

value engineering savings. Mr. Turpin recommends that approximately 20 percent of the value engineering cost saving should accrue to the design consultant.

In turnkey projects, the contractors pricing is driven by the expertise and innovation that can be brought to the project rather than cost competition or profit limitation. Owners must encourage innovation and trust for the success of turnkey projects.

Sergio Gonzales
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Mr. Gonzales recognized the consistency of value engineering (VE), total quality management (TQM), and other quality related approaches. Value engineering as representative of quality optimization, applies to both the design and the construction stages of transit projects. Relative to turnkey with value engineering, conventional projects have several limitations:

- In conventional projects there is a tendency to use the familiar and provenduring design, and a reluctance to consider change. In this context, value engineering, in conjunction with turnkey approaches, can optimize cost savings.
- During construction contractors are limited by the design. Depending on how contractor initiated changes are handled, accepting value engineering based contractor changes can have the effect of limiting competition.

Traditional value engineering when applied to turnkey contractors may not provide adequate incentives to designers. There must be a benefit to the designers for incorporating value engineering proposals.
In Tren Urbano, value engineering was expanded to the procurement process to include: program standards, peer review, industry outreach, procurement law and regulations, and contractor recommendations. The solicitation process in Tren Urbano included:

- initial proposal evaluations for technical proficiency
- price consideration for all technically sufficient proposals
- joint evaluations of technical and cost proposals
- optimization phase detailed negotiations and evaluations involving the proposers and the Authority
- requests for best and final proposals.

Mr. Gonzalez observed that while the value engineering procurement approach has been successful in resulting in life cycle cost savings, there have been both positive and negative comment from contractors. As applied in Tren Urbano, value engineering has resulted in over $50 million in cost savings. Several specific value engineering cost savings include communications, train control, power, station finish elements, warrantees, insurance and risk allocation.

In summary, the speaker concluded that:

- the objective of value engineering is to optimize the entire project procurement and implementation
- the turnkey process must continue to be evaluated
- the turnkey project approach is value engineering.

Discussion

There were several comments and questions relative to the extent of owner and contractor shares of the cost savings generated by value engineering. The consensus of the participants was that the conventional 50-50 split between owners and contractors for initial savings was tradition rather than equity. It was further the consensus that there is no clear answer as to what is a fair allocation of the value engineering savings, particularly with regard system wide and industry wide value engineering generated savings.

It was noted that it is difficult to quantify time savings as related to value engineering outcomes. Several of those present cautioned conservative quantification of the savings derived from value engineering. Nevertheless, it was repeatedly stated that value engineering results in significant and substantial savings over the life of conventional and turnkey projects.