VALUE ENGINEERING METHODOLOGY DURING AN ECONOMIC RECESSION
“THINKING OUTSIDE THE BOX”

An Interactive Paper and Presentation

By

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ABSTRACT

The authors of the paper have performed over 40 Value Engineering studies together. Based on their experience, they have selected two similar transportation projects that were subjects of Value Engineering, one from and during better economic times and one from and during a more recent recessionary period. A comparison of the selected projects indicates the following:

Project 1, which was during the pre-recessionary period, was subject to rejection of many of the “Outside the Box” ideas due to non-compliance with the existing design guidelines. Project 2, which was in the more recent recessionary times, saw the implementation of ideas similar to the ones rejected in the earlier study. The difference in results between implementation of similar ideas was due to the fact that the stakeholders had the foresight to anticipate changes in economic times and executed special studies to modify design guidelines and manuals to suit current economic circumstances.

These examples leave the opportunity for further debate on currently existing guidelines, policies and manuals on our nation’s transportation infrastructure:

1) Can we revise existing practices, guidelines, policies and manuals to accommodate more “outside the box” alternatives?

2) Will making designs fit today’s needs and circumstances compromise our infrastructure in any way?

3) Are we ready to implement and encourage creativity?

WHAT IS A RECESSION?

As defined in the Dictionary, “A recession is a temporary depression in economic activity or prosperity”. It could also be better defined as, “A recession is a business cycle contraction, a general slowdown in economic activity over a period of time” (Wikipedia). Macroeconomic indicators such as production, employment, investment spending, capacity utilization, household incomes, business profits and inflation fall during recessions while bankruptcies and unemployment rates rise. This results in a general drop in spending. Governments usually respond to recessions by adopting expansionary macroeconomic policies, such as increasing money supply, increasing government spending and decreasing taxation. The citizens must use all of their skills to manage their resources to get through such a cycle. Likewise, the
government agencies can’t help but be affected by the slowing tax revenues and, perhaps the increasing cost of doing business. This requires the agency managers to garner their resources and do more with less.

In such times, the focus necessarily falls on the first cost of doing business – building bridges, maintaining roads, updating overburdened infrastructure. There has been so little attention paid to life cycle costs, it is no surprise that the realization is slow in coming that life cycle cost represents a future entitlement program that is being agreed upon even as low first costs are being accepted. In other words, getting projects into a manageable cost range is too often done without maintaining the high quality necessary to look after tomorrow’s dues to be paid. This is why we call it a future entitlement. You won’t have much choice in that you will have to spend more to maintain the facilities if you are making bad choices today. In difficult times, it is often hard to avoid less than acceptable choices due to the need for project completions.

THIS IS WHERE VALUE ENGINEERING METHODOLOGY STEPS IN

This scenario is ideal in applying the Principles of the Value Engineering Methodology. Value Engineering is not only a cost-reduction methodology (ex: Cost-Worth Analysis and Implementation) while retaining the Functions and Objectives of, say, developmental programs. It fosters thinking outside the box and moving beyond traditional methods to realize the maximum potential for expenditures. The FAST diagram, in conjunction with other Value Engineering principles such as the Cost/Worth Ratio, would uncover hidden expenses and identify unique cost-saving strategies which in better times would have been overlooked. Life Cycle Cost and Risk Analysis will strengthen the decision making process in the implementation of the recommendations. The FAST diagram helps to raise the question of “What other way can we do this?” also, “Can we meet the objectives and specifications through changes that result from necessarily having to re-think our normal approach to design and project construction?” The process of Risk Analysis calls for the delivery team to generate creative ways to minimize or avoid risks. Almost always on the risk register is the risk of overrunning available funding.

OBJECTIVES OF THE PAPER - CASE IN POINT

A good example of a transitional phase from a healthy economy to a downtrend has been observed over the past three years. This paper makes a comparative parametric evaluation of projects executed during economic recessionary periods as compared to similar projects delivered during periods of economic growth. The contents of the paper are derived from the authors’ experiences in applying the Value Methodology and Risk Analysis on infrastructure projects, specifically transportation, across the country for various agencies. Subject projects, similar in function, are selected to showcase the comparative evaluation. Within the selected projects, this paper focuses on the comparison of the Bridge Features.
DESCRIPTION OF SELECTED PROJECTS

Project 1: STP-004-2(31) – P.I. No. 322540 “North Gray Bypass - Jones County”.

Project Date: 2002
Project Cost: $26,367,131
VE Workshop Date: 2010

The project was needed to provide improved travel conditions for the public and the fluid movement of increased freight on US 129/SR22.

The project was proposed to begin at the intersection of SR 18 with SR 22, just west of Clinton. The road then proceeded in northwesterly, northerly easterly and thence southeasterly directions to a terminus with SR 22 at mile post 11.21 east of the City of Gray. The total length of the project was approximately 6.0 miles.

To accommodate the traffic projections, the typical section was to be a rural four lane roadway with a 44 foot depressed median on a 250 foot of Right-of-Way. The design speed was 55 mph.

To enhance the safety at the Norfolk & Southern Railroad, the crossing of the railroad was proposed to be grade separated. Two parallel bridges approximately 230 feet in length were proposed to be constructed over SR 11 and the railroad.

Project 2: STP-218-01(1) – P.I. Nos. 522790 & 0007259 "Jimmy Deloach Parkway Extension" and "Jimmy Deloach Parkway at US 80 proposed new interchange".

Project Date: 2008
Project Cost: $33,166,219
VE Workshop Date: 2010

The extension connected the Jimmy Deloach Parkway from its intersection with US 80 to I-16 at its interchange with SR 17 via a portion of the existing SR 17 ROW and a new alignment. This project was located in the western portion of Chatham County, Georgia.

The project served as a divided principal or major four lane arterial route. The project as proposed would include four new 12-ft. travel lanes separated by a median of variable width (24' to 44'). Provision for bicycles was provided on the new paved shoulders. Grade separation was provided over the CSX railroad and a bridge to cross the Ogeechee River. The new interchange project at US 80 was intended to provide a grade separation between US 80 and the Jimmy Deloach Parkway. The project was also intended to provide a high level of traffic service between major sections of the urbanized area and to provide for the safe and efficient movement of traffic between longer trips within and through the area. The project was designed to traverse wetlands, the City of Bloomingdale, the CSX railroad, and numerous residential and commercial properties. Also, to accommodate the project and provide access to the area traffic, realignment of other roads were to be performed.
THE VALUE ENGINEERING (VE) PROCESS

For both projects, the Value Engineering Team(s) followed the Value Engineering job plan as promulgated by SAVE International. This Seven Step job plan included the following:

Investigation/Information Phase: During this phase of the VE Team’s work, the team received a briefing from the Georgia Department of Transportation (GDOT) staff and design consultant. This briefing included discussions of the design intent behind the project, the cost concerns, and the physical project limitations. In the working session that followed, the VE Team developed cost models, using the Pareto Model identifying the highest costs down to the lowest costs for the larger construction cost elements. This model was created from the cost data provided by the designers. The team also familiarized themselves with the construction drawings and other data that was available to the team.

Function Analysis Phase: During this phase, the VE Team determined the Function Cost-Worth” “Functions” of the project. This was accomplished by reviewing the project from the simplest format in asking the questions of “What is the project supposed to do?”, and “How is it supposed to accomplish this purpose? In the Value Engineering vernacular, the answers to these questions are cast in the form of active verbs and measurable nouns. These verb/noun pairs form the basis of the function analysis which distinguishes a Value Engineering effort from a potentially damaging cost cutting exercise. For Project 1, a Function Cost-Worth approach was adopted while for Project 2 a FAST diagram was prepared to highlight the project’s required functions.

To further highlight similarities of the subject projects, the above exercise during the Analysis Phases identified like important functions of the projects as follows:

- Project Objective/Goals
  - Enable/encourage the growth of the economy
  - Reduce travel time
  - Provide bicycle access

- Project Basic Functions
  - Provide connectivity
  - Separate grade intersection

Speculation Phase: The VE team performed a brainstorming session to identify ideas that might help meet the project objectives. Some of the key topics in this brainstorming session included:

- Eliminate any unnecessary work while maintaining project functional requirements
- Identify other means of providing function requirements
- Improve service
- Reduce impact to wetlands
This brainstorming session initially identified numerous ideas that were then evaluated in the Judgment phase. These same work sheets were also used to record the results of the judgment/Evaluation Phase.

**Evaluation Phase:** Once the VE Team identified the creative ideas, it was necessary to decide which alternatives should be carried forward. This is the work of the Evaluation or Judgment Phase. The VE Team reflected back on the project constraints and objectives shared with the team by the owner’s representatives, in the kick-off meeting on the first day of the workshop. From that guidance, the team selected ideas that they believed would improve the project and that were capable of being implemented should they be selected by the Owner. It is good practice to remind the team members that alternatives that are to be advanced must meet the requirement that the team member championing the idea would not be hesitant to use such an idea on their own design projects.

Following that selection process, the VE Team used the following values as measures of whether or not an alternative had enough merit to be carried forward in the VE process:

- Construction cost savings
- Improve value
- Enhance Maintainability
- Ability to implement the idea
- General acceptability of the alternatives
- Constructability
- Would not generate project delays
- Enhance Safety

Based on these criteria, the VE Team evaluated the alternatives and graded them from 5 (Excellent) down to 1 (Poor).

**Development Phase:** During this phase, the VE Team developed each of the selected design alternatives whose rating was “4” or “5”. This effort included a detailed explanation of the idea with sketches as appropriate to clarify the idea from the original concept, advantages and risks, a technical explanation and an estimation of the cost and resultant savings if implemented. Also, when appropriate and documentable, the comparative life cycle costs for the original and alternative designs are identified.

**Recommendation Phase:** During this phase the VE Team reviewed the alternative ideas to confirm which ones were appropriate for the project, have an opportunity for success and which would improve the value of the project if implemented.

**Presentation Phase:** The team made an informal “outbriefing” on the last day of the workshop, designed to inform the Owners and the Designers of the initial findings of the VE Study.
OUTCOME OF THE VE PROCESS AS APPLIED TO PROJECT 1 AND PROJECT 2
APPLICATION OF THE PARETO COST MODEL

Figures 1 and 2 below show the Pareto Cost Models developed for each of the Projects 1 and 2 respectively. Note that the cost of the subject Bridge in Project 1 is about 8% of the total cost of the project while that of the subject Bridge in Project 2 is about 9% of the total cost of the project. These two components of the project will be the focus of this paper.

Figure 1: Pareto Cost Model for Project 1 - STP-004-2(31) – P.I. No. 322540 “North Gray Bypass - Jones County”.

![Pareto Cost Model for Project 1](image-url)
Figure 2: Pareto Cost Model for Project 2 - STP-218-01(1) – P.I. Nos. 522790 & 0007259 “Jimmy Deloach Parkway Extension" and "Jimmy Deloach Parkway at US 80 proposed new interchange".
**APPLICATION OF THE FUNCTION ANALYSIS**

During the Analysis Phases, for Project 1, a Function Cost-Worth approach was adopted while for Project 2 a FAST diagram was prepared to highlight the projects required functions. Figure 3 below shows the Cost-Worth Table for Project 1 while Figure 4 shows the FAST Diagram for Project 2.

**Figure 3: Cost-Worth Table for Project 1 - STP-004-2(31) – P.I. No. 322540 “North Gray Bypass - Jones County”**

<table>
<thead>
<tr>
<th>No</th>
<th>Element</th>
<th>Function</th>
<th>Cost (SK)</th>
<th>Worth (SK)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OVERALL PROJECT</td>
<td>Increase Traffic Capacity</td>
<td>26,367</td>
<td>20,000</td>
<td>C/W=1.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Facilitate Access</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enhance Safety</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>BASE AND PAVING</td>
<td>Create Lanes</td>
<td>8,679</td>
<td>8,679</td>
<td>C/W=1.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increase Capacity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enhance Safety</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>GRADING</td>
<td>Support Road</td>
<td>2,500</td>
<td>2,000</td>
<td>C/W=1.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Avoid Flooding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Connect Points</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>BRIDGE</td>
<td>Cross Road and RR</td>
<td>1,835</td>
<td>1,500</td>
<td>C/W=1.22</td>
</tr>
<tr>
<td>5</td>
<td>CLEAR &amp; GRUBBING</td>
<td>Remove Vegetation</td>
<td>1,200</td>
<td>800</td>
<td>C/W=1.50</td>
</tr>
<tr>
<td>6</td>
<td>EROSION CONTROL</td>
<td>Stabilize Earthwork</td>
<td>955</td>
<td>955</td>
<td>C/W=1.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Protect Environment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>DRAINAGE(DR)</td>
<td>Convey Storm Water</td>
<td>804</td>
<td>804</td>
<td>C/W=1.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Facilitate Utilize</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>LANDSCAPING</td>
<td>Stabilize Earthwork</td>
<td>521</td>
<td>521</td>
<td>C/W=1.00</td>
</tr>
<tr>
<td>9</td>
<td>TRAFFIC CONTROL</td>
<td>Facilitate Movement</td>
<td>262</td>
<td>262</td>
<td>C/W=1.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enhance Safety</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>SIGNING AND MAKING</td>
<td>Enhance Direction</td>
<td>126</td>
<td>126</td>
<td>C/W=1.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Channelize Traffic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>GUARDRAIL SYSTEM</td>
<td>Enhance Safety</td>
<td>122</td>
<td>122</td>
<td>C/W=1.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduce Earthwork</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Function defined as: Action Verb Kind: B = Basic HO = Higher Order Cost/Worth Ratio = (Total Cost / Basic Worth)
Figure 4: FAST Diagram for Project 2 - STP-218-01(1) – P.I. Nos. 522790 & 0007259 “Jimmy Deloach Parkway Extension" and "Jimmy Deloach Parkway at US 80 proposed new interchange”.

FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST)
DIAGRAM

HOW

WHY

CONNECT ROADWAYS

CONNO

FUNCTIONAL

SYSTEM

TECHNIQUE

(INCREASE
CAPACITY) (CONTROL ACCESS)

REDUCE ACCIDENTS

REDUCE CONFLICT POINTS

IMPROVE SIGHT DISTANCE

ASSURE CONVENIENCE

IMPROVE TRAFFIC ACCESS

MAINTAIN ACCESS DURING CONSTRUCTION

ASSURE DEPENDABILITY

MEET STANDARDS

ELIMINATE NON FUNCTIONAL WORK

MEET LOCAL EXPECTATIONS

REDUCE RESIDENTIAL RELOCATION

REDUCE CONSTRUCTION IMPACTS

ATTRA

EMPHASIZE NATURAL RESOURCES

REDUCE RESIDENTIAL RELOCATION

MINIMIZE ENVIRONMENTAL IMPACTS

MINIMIZE GREEN SPACE IMPACT

EMPHASIZE NATURAL RESOURCES

MINIMIZE GREEN SPACE IMPACT

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CREATIVE IDEAS LISTING

Numerous creative ideas for design alternatives were listed during the brainstorming session for each of the projects. The Function Cost/Worth table resulted in a cost/worth ratio of 1.22 for the bridge in Project No. 1. This ratio typically indicates that this bridge and its cost are good candidates for attention during the creative/brainstorming work session. Likewise, and noted earlier, the FAST diagram for Project No. 2 quickly identified functional headings that posed questions such as, “How else can we do this?” This is real food for the creative/brainstorming portion of a VE workshop.

EVALUATION PHASE

Based on the ranking system used during the evaluation phase, a selection of the ideas pertaining to the bridge items were identified for development and presentation to the stakeholders. Some of these ideas/alternatives that were selected to be showcased in this paper are listed below. The tables also include resulting savings as a difference between the Original Design Costs and Alternative Design Costs.

Figure 5: Selected Developed Creative Ideas Table for Project 1 - STP-004-2(31) – P.I. No. 322540 “North Gray Bypass - Jones County”.

<table>
<thead>
<tr>
<th>DESIGN ALTERNATIVE</th>
<th>DESCRIPTION</th>
<th>COST SAVINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR-1</td>
<td>Use 2’ inside buffer in-lieu of 4’ shoulder</td>
<td>$92.25k</td>
</tr>
<tr>
<td>BR-2</td>
<td>Use 6’ outside shoulder &amp; 2’ inside buffer in-lieu of 10’ and 4’</td>
<td>$276.75k</td>
</tr>
<tr>
<td>BR-4</td>
<td>Use 3 Span Bridge with MSE walled abutments</td>
<td>$54.75k</td>
</tr>
<tr>
<td>BR-6</td>
<td>Use MSE walled abutments on East end of Bridge</td>
<td>$105.00k</td>
</tr>
<tr>
<td>RD-2</td>
<td>Use median with positive barriers in-lieu of 44’ median</td>
<td>$10,154.00k</td>
</tr>
</tbody>
</table>

Figure 6: Selected Developed Creative Ideas Table for Project 2 - STP-218-01(1) – P.I. Nos. 522790 & 0007259 “Jimmy Deloach Parkway Extension" and "Jimmy Deloach Parkway at US 80 proposed new interchange”.

<table>
<thead>
<tr>
<th>DESIGN ALTERNATIVE</th>
<th>DESCRIPTION</th>
<th>COST SAVINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>RD-1</td>
<td>Use a 32’ depressed median in-lieu of 44’depressed median</td>
<td>$610.00k</td>
</tr>
<tr>
<td>RD-22</td>
<td>Use MSE walled abutments to provide a Single Span Bridge</td>
<td>$267.00k</td>
</tr>
<tr>
<td>I-3</td>
<td>Use Single Span Bridge with MSE walled abutments</td>
<td>$78.00k</td>
</tr>
<tr>
<td>I-6</td>
<td>Use 40’ End Spans on Bridges across US 80</td>
<td>$210.00k</td>
</tr>
</tbody>
</table>

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DEVELOPED ALTERNATIVES

The alternatives developed included a narrative of the original design as compared to the design alternative including advantages and risks associated with the alternative. Sketches were developed to support the recommendations, and rough order of magnitude cost estimates were developed along with cost worksheets to include life cycle costs.

Figures 7 and 8 illustrate selected original design sketches along with those for the corresponding design alternatives.

A summary of the advantages in implementing all the design alternatives for both projects combined are listed below.

- Potential savings in construction costs and time due to reduced bridge lengths
- Reduction in intermediate bents
- Reduced maintenance requirements
- Improved construction staging
- Additional construction staging area made available
- Enhanced Aesthetics
- Potential for lowering of Profile Grade which in turn reduces earthwork and ROW requirements

RISK ANALYSIS

There are inherent risks involved with the implementation of the “Outside the Box” ideas which range from non-compliance with existing design manuals and/or guidelines to requiring approval or acceptance of variance to implement such design. Risks associated with the recommended design alternatives on the subject projects are summarized below:

Summary of risks of recommended design alternatives common to both projects:

- Minimal redesign effort (as the design is in the preliminary phase)
- Additional MSE Wall, Fill and Paved Roadway requirements
- Design exception may be required
- Risks in terms of liability
Figure 7: Illustrations for Project 1 - STP-004-2(31) – P.I. No. 322540 “North Gray Bypass - Jones County”. 
Figure 8: Illustrations for Project 2 - STP-218-01(1) – P.I. Nos. 522790 & 0007259 “Jimmy Deloach Parkway Extension" and "Jimmy Deloach Parkway at US 80 proposed new interchange".
IMPLEMENTATION

The final implementation of the Value Engineering Study recommendations for the projects yielded the following results:

Project 1 (2002) - “North Gray Bypass - Jones County”:

Of the 17 Developed ideas that were presented to the stakeholders, only five were accepted for implementation. None of the ideas summarized in this paper were accepted. Most reasons cited for non-acceptance were non-compliance with then existing State and AASHTO Design Guidelines.

Project 2 (2008) - “Jimmy Deloach Parkway Extension” and "Jimmy Deloach Parkway at US 80 proposed new interchange”:

Of the 8 Developed ideas that were presented to the stakeholders, 4 were accepted for implementation including two of the ideas summarized in this paper pertaining to lane widths and shoulder widths.

Notably, by the time of the second study, a separate Value Engineering and Risk Assessment study had been conducted by GDOT on existing AASHTO Guidelines to make modifications to State Design Guidelines and their acceptability subject to other project specific conditions. Modifications included the consideration of 11 foot wide Travel Lanes, interior or all; reduction in shoulder widths along Roadway and Bridge Structures; reduction in Median Requirements; and using MSE walled abutments in-lieu of approach spans.

CONCLUSION

A comparison of the selected projects indicates the following:

Project 1, which was during the pre-recessionary period, was subject to rejection of many of the “Outside the Box” ideas due to non-compliance with then existing design guidelines. Project 2, which was during more recent recessionary times, saw the implementation of similar ideas. The difference in acceptance or rejection for implementation of similar ideas was due to the fact that the stakeholders had the foresight to anticipate changes in economic times and executed special studies to modify design guidelines and manuals to suit current circumstances. Notably, this is in accordance with FHWA encouragement to utilize Context Sensitive Design (CSD) judiciously. Such CSD applications have embraced previously unheard of design variances such as employing 11 foot wide Travel Lanes, interior or all; reduction in shoulder widths along Roadway and Bridge Structures; reduction in Median Requirements; and using MSE walled abutments in-lieu of approach spans. The acceptance of these alternatives is subject to project conditions including when horizontal and vertical site distances are not an issue and where the design speed is low and traffic lane access and egress are not closely spaced.
These examples leave the opportunity for further debate on currently existing guidelines, policies and manuals on our nation’s transportation infrastructure:

1) Can we revise existing practices, guidelines, policies and manuals to accommodate more “outside the box” alternatives?

   Building on the successes and learning from trial measures throws a clear light on the path ahead. The future will likely be filled with lower cost, highly efficient, trend setting design methods.

2) Will making designs fit to today’s needs and circumstances compromise our infrastructure in any way?

   The design and construction industry is alive with new geometric approaches, new material applications and driven by strong safety requirements and the desire to provide the DOTs, the end users and the tax payers with highly efficient and cost effective transportation corridors. These approaches will be applied by practitioners that are excited about cutting edge technology while being ever mindful of the consequences of making a false step in the application of their knowledge. This creates a very healthy tension for us all.

3) Are we ready to implement and encourage creative “Outside the Box” thinking?

   It is rewarding to see other developments that were not in the “design playbook” in years past. Some of these have included the use of roundabouts and the use of left turn flashing amber arrows to promote efficiency/fuel economy in areas where the flashing left arrow will work safely. When roundabouts were first introduced into tentative utilization, many DOTs shied away from their use. Further, there was no consideration of roundabouts with more than one lane. Use of two lanes in roundabouts is gaining momentum. Results of the use of roundabouts have included the negation of millions of dollars in life cycle maintenance costs for traffic signalization.
REFERENCES

1) Library of resources at the Lawrence D. Miles Value Foundation website: www.valuefoundation.org.
2) Library of Value Engineering Reports at the Georgia Department of Transportation, Office of Value Engineering (TREX): www.dot.state.ga.us.

ACKNOWLEDGEMENTS

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