



HIGHWAY PROJECT COST ESTIMATING AND MANAGEMENT CONTRACT #308059

By: Sierra Transportation Engineers, Inc.



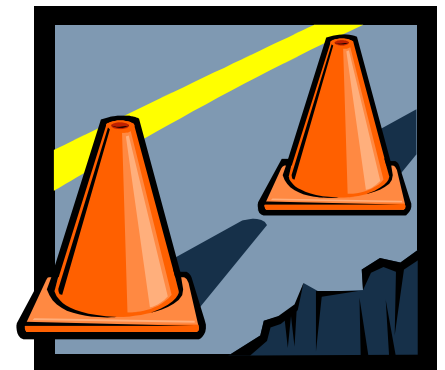
Final Presentation
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Purpose

Develop a comprehensive document to determine the best practices of efficient highway cost estimating for MDT.

Scope of Work

- Literature Review
- Review of MDT's Structure, Operations, & Current Process
- Develop Detailed Strategic Procedure & Recommendations
- Develop Implementation Plan



Literature Review

- Identify cost estimation problems (Problem Identification)
- Identify solutions to improve the cost estimation process (Solutions)
- Identify practices by other agencies for improving the cost estimation process (Best Practices)
- Recommend the best practices of cost estimation for implementation (Recommendations)

Problem Identification

- Cost overrun of infrastructure projects has become a common problem for transportation agencies.
- Inaccurate cost estimates lead to overloading the Statewide Transportation Improvement Program (STIP) with many projects that are underfunded.



Problem Identification

Cost overrun
can lead to
adverse
consequences
including

- ❑ Disruption of plans, postponing, or canceling scheduled projects to satisfy budgetary constraints.
- ❑ Reduction in project scope, resulting in projects that do not fully provide the service initially intended.
- ❑ Extension in construction duration until additional funds become available.
- ❑ The public losing faith in the agency's competency, or worse, trustworthiness.

Problem Identification

**Cost
overrun is
generally
due to**

- ❑ Difficulty in developing a complete scope
- ❑ Difficulty in identifying variability and uncertainty
- ❑ Difficulty in evaluating the quality and completeness of cost estimates
- ❑ Difficulty in tracking costs at various stages

Solutions (Cost Estimation Management)

1. Make estimation a priority by allocating time and staff resources
2. Set a project baseline cost estimate during programming or early in preliminary design and manage to it throughout project development
3. Create cost containment mechanisms for timely decision making that indicate when projects deviate from the baseline
4. Create estimate transparency with disciplined communication of the uncertainty and importance of an estimate
5. Protect estimators from internal and external pressures to provide low cost estimates

Solutions (Cost Estimation Practice)

1. Complete every step in the estimation process during all phases of project development
2. Document the estimate basis, assumptions, and back-up calculations thoroughly
3. Identify project risks and uncertainties early
4. Anticipate external cost influences and incorporate them into the estimate
5. Perform estimate reviews to confirm the estimate is accurate and fully reflects project scope



Examples of Best Practices

Mn/DOT Vision Statement

Mn/DOT will manage and control costs through a department-wide priority on cost estimating and cost management, reliable and accurate estimates, statewide uniformity and consistency, improved communication and credibility with external stakeholders, and clear accountability.

Best Practices & Recommendations

| Actions | Example Agencies |
|--|---|
| Developing Cost Estimating Manual | Maryland, Minnesota, Virginia, Washington, California |
| Developing Systems for Capturing Risk Factors | Washington, Florida |
| Developing Cost Estimate Training Program or Workshops | Virginia, Washington, Michigan |
| Establishing Cost Estimating Department | Louisiana, Nevada |
| Develop of Estimating Quality Control Program | Indiana, Maine, Virginia, Washington, Wyoming |

MDT's Current Process

Topics Evaluated

- MDT's existing cost estimating procedures.
- Tracking of project cost estimates throughout the different phases of the project development process.
- Development of an Excel based documentation tool for tracking historic cost estimates versus actual completed costs.
- Recognizing different issues that increase complexity of developing accurate cost estimates.

MDT's Current Process

- Data Request Template
- Pre-Trip Questions
- Staff Interviews



| Insufficient Knowledge of Right-Of-Way Factors | | |
|---|---|-----|
| | (\$) | |
| | Change in Project Cost | |
| | If available break down this cost in the following subcategories: | |
| Subcategories | (\$) | (%) |
| a. Disagreement on freeway access | | |
| b. Objections to ROW appraisal | | |
| c. Acquisition problems | | |
| d. Staffing issues | | |
| e. Volatile real estate market/rapid escalation | | |
| f. Others (please specify) | | |
| | | |
| | | |

Recommendations

- ❑ Create cost estimation section
- ❑ Routine updates of unit cost data on MDT intranet
- ❑ Develop comprehensive cost estimating manual
- ❑ Develop quality control and quality assurance program for cost estimating
- ❑ Develop comprehensive system for capturing risk factors
- ❑ Create procedures for managing inflation
- ❑ Establish routine training program for staff involved in cost estimating

Cost Comparison at Various Stages

$$\text{Cost}(t_2) = \text{Cost}(t_1) +$$

Known Contingencies +
Unknown Risks



Definition of Cost

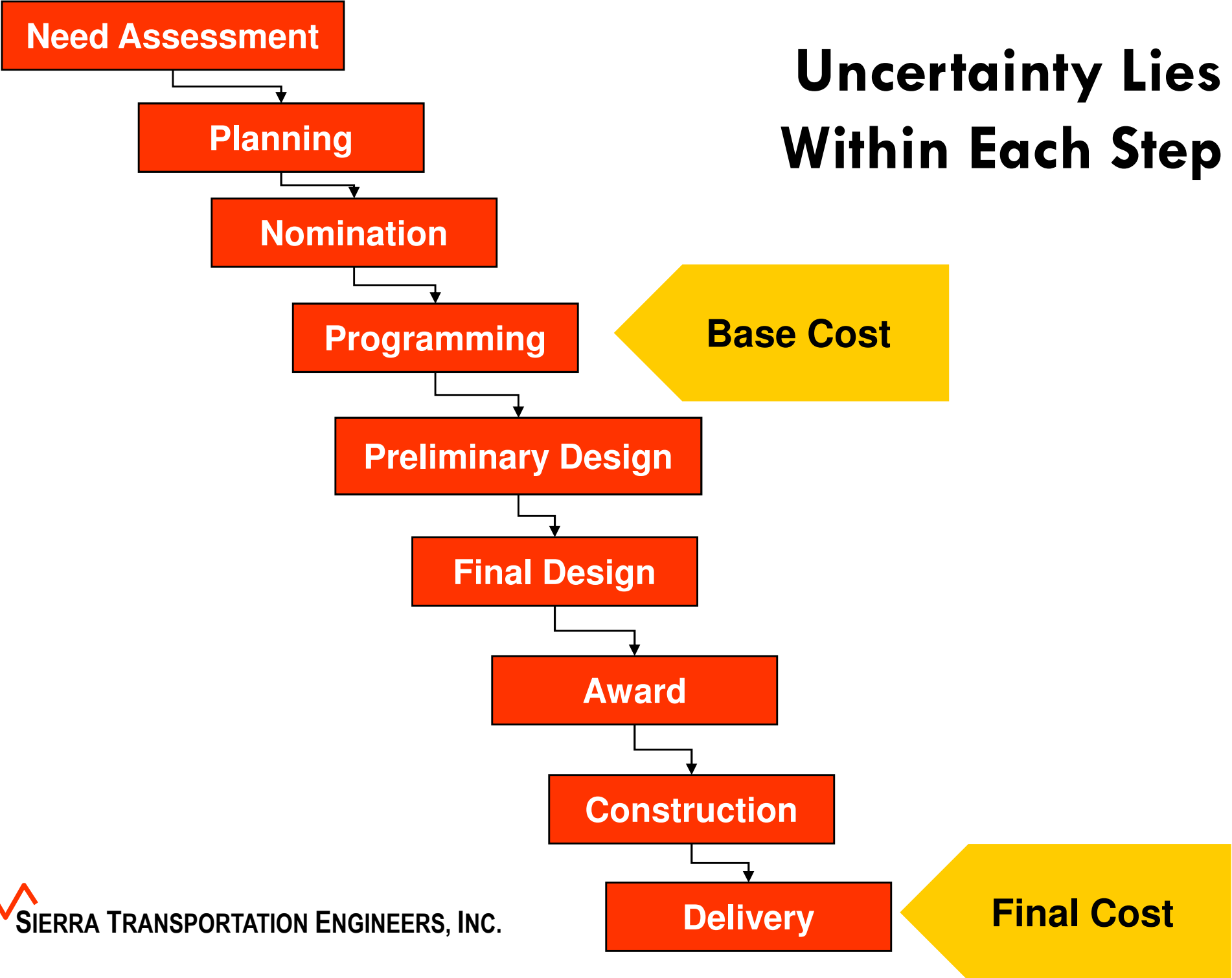
- Project cost estimate at the time of Nomination should be a “total” project cost estimate.
- Include all project related costs such as:
 - Preliminary Engineering
 - Construction Engineering
 - Incidental
 - Right of Way
 - Construction
 - Contingencies
 - Risks
 - Inflation

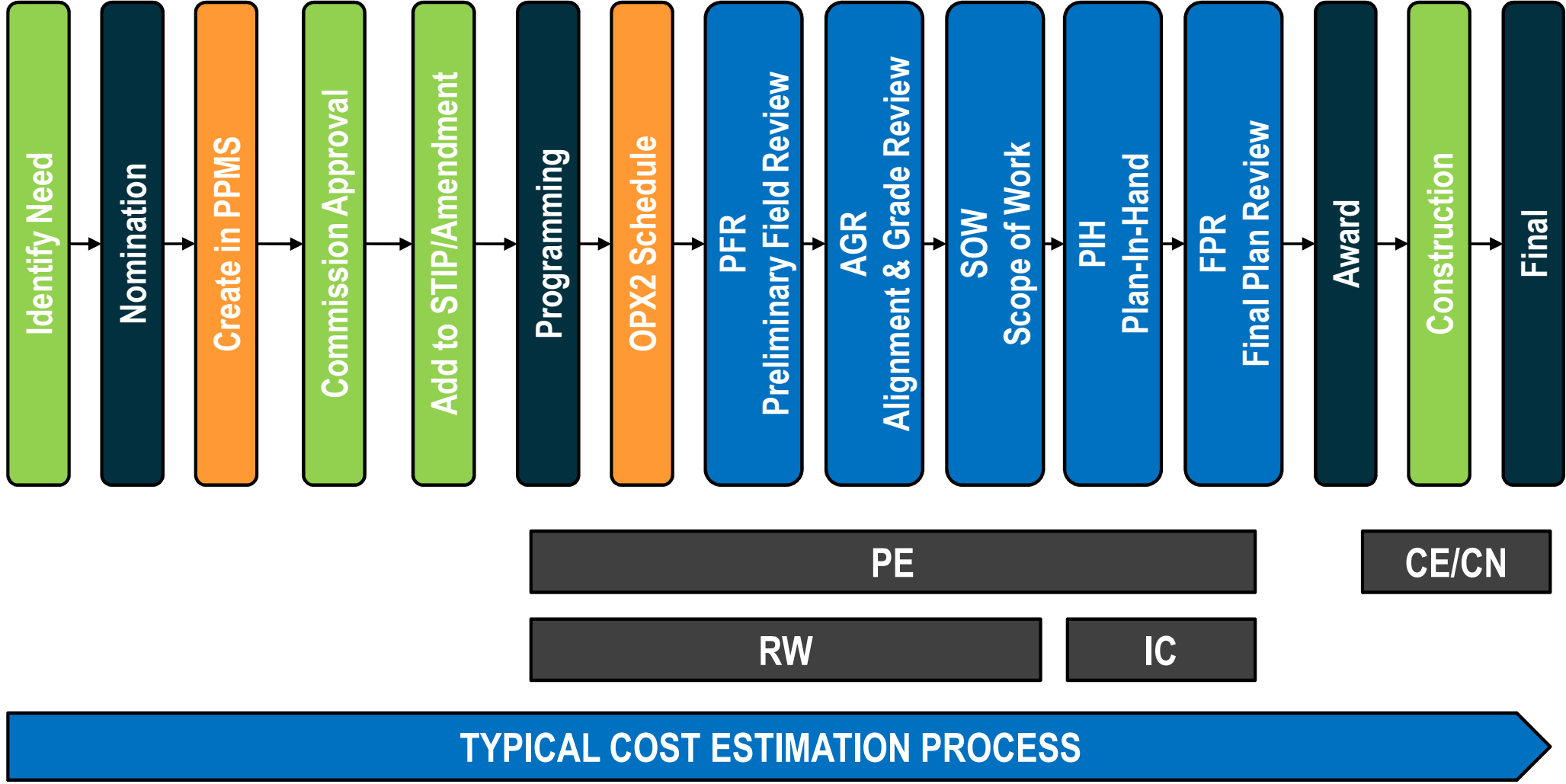
Unknown Risks

- Insufficient Knowledge of Right-of-Way Factors
- Environmental Mitigation Requirements
- Unforeseen Engineering Complexities / Constructability Issues
- Changes in Traffic Control Needs Due to Design or Traffic Growth
- Increased Local Government, Community, and Stakeholders Expectations
- Unforeseen Events
- Changes in Market Conditions
- Utilities
- Others



Uncertainty Lies Within Each Step





Cost Overruns - Example

| Statewide and Urban Section Projects | | | | | |
|---|------------------------------------|---------------------------------|----------------------------|-------------------------|------------------------------------|
| Categories | Initial Estimated Cost (\$) | Latest Revised Cost (\$) | Change in Cost (\$) | % Change in Cost | Sample Size (# of Projects) |
| Preliminary Engineering | 2,671,708 | 12,012,257 | 9,340,549 | 350% | 12 |
| Right of Way | 941,200 | 6,191,929 | 5,250,729 | 558% | 5 |
| Incidental | 424,695 | 7,742,867 | 7,318,172 | 1,723% | 5 |
| Construction | 72,590,606 | 168,132,630 | 95,542,024 | 132% | 17 |
| Total | 75,558,211 | 212,135,976 | 136,577,765 | 181% | 16 |

Cost Overruns - Example

- MDT Highway Projects
 - Based on nine cost data sets.
 - Observed a 41% increase in construction cost estimates from the time of programming to award.
 - Observed a 46% increase in construction cost from the time of programming to final construction.
- More data is required to study the cost changes in MDT Highway Projects.

Tracking Cost & Evaluating Risks

- Complete historical data sets are a must.
- Data sets can be organized by:
 - ▣ Districts
 - ▣ Project Type (e.g., New, Rehabilitation, Reconstruction)
 - ▣ Category (e.g., NH, STPP, BR)
 - ▣ Location (Urban or Rural)
- STE's developed tracking system can be further enhanced to gather future complete project data sets.

Framework of Tracking System



Tracking System Development

- Use internal MDT resources (IT staff, Oracle database) and possible interface with PPMS.

Or

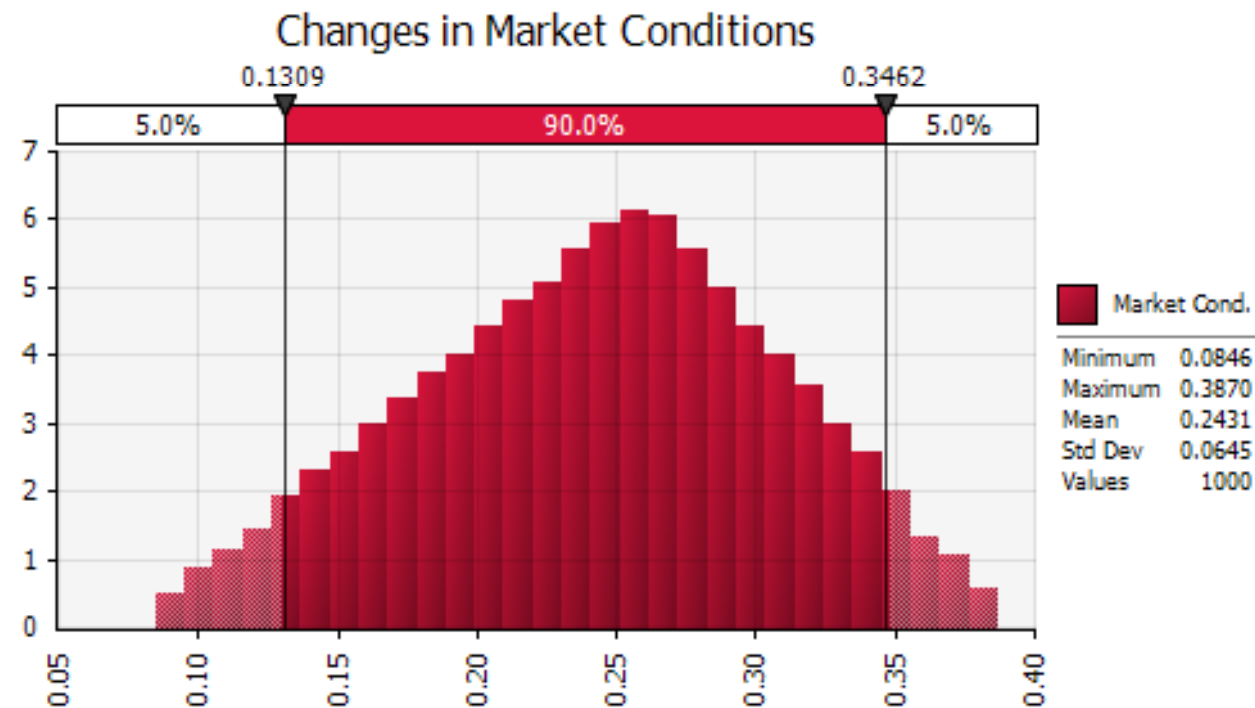
- Further enhance STE's developed tracking system into a standalone application with user-friendly graphical interface.

In either case, add a Monte Carlo simulation tool to quantify risk factors.

Develop Comprehensive System for Capturing Risk Factors

MDT Risk Analysis Program (RAP)

Tracking system with Monte Carlo simulation capability to assess project risk factors.



Accuracy of Inflation Forecasting

MDT historically has used 3% annual inflation rate.

| Year | Cost Index* | % Change (Inflation) |
|--------------------------|--------------------|---------------------------------|
| 2000 | 75 | |
| 2001 | 82 | 9.16% |
| 2002 | 79 | -2.57% |
| 2003 | 94 | 18.32% |
| 2004 | 100 | 6.38% |
| 2005 | 104 | 3.61% |
| 2006 | 139 | 34.12% |
| 2007 | 152 | 9.72% |
| Average Inflation | | 11.25% |

* Cost indices indexed to Year 2004.

Recommendations for Managing Inflation

- For long term planning beyond the framework of the Tentative Construction Program (i.e., five years and longer), use the national forecasted trends or MDT defined inflation (e.g., 3%).



Recommendations for Managing Inflation

- For short term planning of less than five years and within the framework of the Tentative Construction Program, capture the inflation trends for the most volatile highway construction items utilizing the inflation rates established from cost indices.
- Volatile Highway Construction Items
 - ▣ Earthwork, Aggregate, Plant Mix, Asphalt, Reinforcing Steel, Structural Steel, Concrete, and Structural Concrete

Recommendations for Managing Inflation

- Simple curve fitting techniques are ineffective.
- STE recommends “exponential smoothing techniques” over single moving average techniques.
- Unlike single moving averages, where the past observations are weighted equally, exponential smoothing assigns exponentially decreasing weights as the observations get older.

Identified Issues

- Need for more comprehensive guidelines or manual
- Need for quality control and quality assurance program



Create Cost Estimation Section

- Routine (i.e., Quarterly) updates of unit cost data on MDT intranet
- Develop and maintain a comprehensive cost estimating manual with detailed procedures and standardized tools
- Develop standardized formats for reporting projects cost estimates
- Develop quality control program for cost estimating
- Random cost validation checks (quality assurance checks) of project costs at the time of nomination
- Keep the cost estimating methods and tools current
- Maintain the historical cost estimation tracking system
- Provide training on cost estimation activities to MDT staff

Develop Comprehensive Cost Estimating Manual

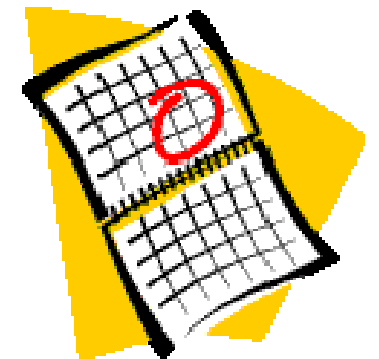
- Estimating Policies
- Estimating Procedures
- Defining Contingency
- Risk Analysis
- Documentation of Estimates
- Defining Roles and Accountability
- Quality Control and Quality Assurance
- Approval of Estimates
- Training Tools



Identified Issue & Recommendation

- Timing of Preliminary Field Review
 - Under existing system by the PFR stage, the project has already been nominated and programmed.
 - Majority of nominated projects are programmed.

- Set a policy for high profile projects to conduct the PFR during the Nomination stage and prior to establishing nomination costs.



Identified Issues

- The degree of knowledge and ability to use available tools varies widely.
- During the interview process, many staff acknowledged the need for further training and communication.



Establish Routine Training Program

- Organization Information
 - ▣ Training materials should include background information on MDT organization and divisions and information on Statewide Transportation Improvement Program, Tentative Construction Program, Urban Projects, and MDT operations.
- Manuals, Tools, & Software Instruction
 - ▣ Training manual composed of materials from all the tools & software used by MDT cost estimating staff.

Establish Routine Training Program

- Improve the flow of information on factors affecting the cost estimation
- Introduce new practices of project cost estimation
- Reinforce the commitment of the department to the importance of improving cost estimation process

Implementation Plan



Create Cost Estimating Section

- STE recognizes that MDT will be hiring two full time estimators, however, a standalone section is not anticipated.
 - ▣ Within the next 6 months MDT should finalize the roles and responsibilities of the two full time estimators and hire them.
 - ▣ Within the following six months the estimators should establish the framework for activities listed in the report.

Develop a Comprehensive System for Capturing Risk Factors

- Within the next 12 months MDT should complete and make operational the system for capturing risk factors as described in the report.



Create Procedures for Managing Inflation



Within the next six months MDT should establish procedures for managing inflation based on recommendations described in the report.

Establish Routine Training Program

- Within the next 12 months MDT should establish a routine training program as described in the report.
- MDT should conduct the first round on training within a year from the completion of this report.

Performance Indicators

- STE believes that its recommendations will enhance the MDT's cost estimating practices.
- The most significant performance indicator is to get cost/schedule estimates that more accurately reflect the final construction cost/schedule.
- Development of a comprehensive system for capturing risk factors is a must.
- MDT will see reductions of historical risk factors over time.
- It will take a 5 year cycle of the Tentative Construction Program to assess the improvements.

Questions



Adjournment

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