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Enhanced Cost Estimating and Project Development Procedures for MPOs: Final Report

Technical Report 0-6929-1

Cooperative Research Program

TEXAS A&M UNIVERSITY–KINGSVILLE
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in cooperation with the
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16. Abstract

Metropolitan planning organizations (MPOs) can improve their transportation plans by enhancing the accuracy of preliminary cost estimates and projected letting dates for proposed projects. Inaccurate cost estimates and letting dates may lead to significant negative repercussions, including delays or cancelations of anticipated improvements, and can even result in cascading effects on the viability of other planned development. To address this problem, the research team delivered a new procedural guidebook to enhance the accuracy of project scope, cost estimates, and letting dates for projects in Texas MPOs' transportation plans. The guidebook was developed based on a rigorous analysis of best practices in MPOs and Departments of Transportation (DOTs) from across the nation that had a demonstrated record of success in meeting their target costs and schedules. The guidebook will enable MPOs to increase their confidence in their budgeting and scheduling, and will ultimately result in greater transportation benefits for the public with fewer delays and at a lower cost. The current report documented the research effort for implementing the project and developing the guidebook.

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ENHANCED COST ESTIMATING AND PROJECT DEVELOPMENT PROCEDURES FOR MPOS: FINAL REPORT

0-6929-R1

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DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

This report is not intended for construction, bidding, or permit purposes. The principal investigator of the project was Amir Hessami, and Dazhi Sun served as the co-principal investigator.

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

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Chapter 1: Introduction

The objective of this research was to enhance the accuracy of preliminary cost estimates and proposed letting dates of projects submitted to local Metropolitan Planning Organizations (MPOs) in the state of Texas. This was accomplished by creating project scoping, scheduling, and cost-estimation procedures that are specifically tailored for Texas MPOs. The procedure guidelines developed in this research were based on rigorous research into best-practices knowledge from across the nation; they were also tailored to the specific local contexts of Texas and based on realistic empirical data. These guidelines are better defined, more streamlined, and more accurate than previous cost-estimation and scheduling procedures employed by many MPOs, thereby eliminating inefficiencies and allowing Texas MPOs to provide greater transportation benefits to the public at lower cost. The implementation of these new procedures by MPOs can be flexible and gradual enough so that they do not cause disruptions or radical changes in ongoing development processes.

1.1. Background

Accurate cost estimation and project scheduling is vital for the success of long-range transportation planning. However, obtaining this accuracy can be very difficult, since preliminary cost and scheduling estimates involve numerous sources of uncertainty, such as market prices, users' needs, supply chains, weather conditions, and unexpected site characteristics, among others (Anderson, 2006). Transportation agencies have been vigorously seeking improved methods of cost estimation and management, devoting resources to obtaining detailed reviews of prepared estimates, better verification of projected costs and schedules, clearer internal and external communications, and better project tracking. MPOs have a responsibility to work with local governments to ensure that costs and schedules of proposed projects are reasonable and that project estimates are updated and communicated as the project design develops. They also need to be able to quickly identify any changes or contingencies that may affect costs and scheduling. The project scope, cost estimates, deadlines, and related assumptions and uncertainties should be clearly communicated and agreed upon by all stakeholders (Goetz, 2002).

The current research will help to improve Texas MPOs' transportation planning by enhancing the accuracy of preliminary cost-estimates and proposed project letting-dates. The final deliverables of the research include a procedural guidebook for developing project scoping, cost estimates, and schedules. Creating guidelines for cost-estimation and scheduling based on a robust analysis of nation-wide best practices and rigorous empirical research into local Texas market realities is a great improvement over current ad-hoc approaches. This will allow Texas MPOs to improve their confidence in the accuracy and consistency of their transportation planning, in order to better serve the public.

The research deliverables can be implemented by Texas MPOs simply by adopting the guidebook for use in their project evaluation practices. The guidebook has been designed so that it can be adopted in a gradual and flexible manner, therefore avoiding any radical disruptions in existing practices. The guidebook development was focused on making adjustments in procedural areas that have been empirically determined to be crucial for improving the success of

Texas MPOs' cost and scheduling estimates. The guidebook contains valuable templates and forms for analyzing project pricing and scheduling, as well as general instructions about best practices.

1.2. Research Framework

To successfully accomplish the objectives of the project and develop the project deliverables, the research team began by analyzing current practices (both in Texas and across the nation) for transportation-project cost estimation and scheduling procedures. The effectiveness of various practices was analyzed empirically, and the team examined local Texas conditions to evaluate what procedures seem best suited for Texas MPOs. The best-practices that were identified were compared with existing procedural frameworks throughout Texas, to determine the nature and extent of the gaps between current and optimal procedures, and to identify the most crucial areas where procedural improvements can lead to greater success. After that step was completed, the accumulated information was used to develop the procedural guidebook and a detailed research report.

1.3. Research Tasks

The overall work plan for this research was divided into seven specific tasks, each of which had a well-defined approach and specific subtasks, expected outcomes, and deliverables. These tasks are outlined in the following sections. A separate, more detailed project management plan was also submitted to TxDOT's RTI office prior to the start of the substantive research.

Task 1: Project Management and Startup

The goal in this task was to determine the best management plan for successfully achieving the project objectives and deliverables while remaining on schedule and within the project budget. The primary researchers developed the details of the project scheduling, organization, and implementation.

The research team developed the management plan based on established Project Management Institute (PMI) knowledge areas. The project management process began with a kick-off meeting in the first week of October 2016 to discuss this implementation. The outline of the management plan included monthly progress reports to summarize completed activities and emerging issues of concern, as well as quarterly progress meetings with the TxDOT team to review the progress of the work. A close-out meeting was held during the first week of August 2017 to discuss the success of the final deliverables.

Task 2: Define the State of the Practice

The research team analyzed the current state of practice in cost estimation and scheduling procedures for the planning of transportation projects across the United States. The practices examined included methods of cost estimation during the planning and programming stages of project development, existing guidebooks and software tools, and project documentation and

approval processes. Information was collected about the effectiveness of these practices in achieving accurate cost estimates and project letting dates.

There were three methods that were used to assess the current state of the practice. The first was an extensive literature review and the collection of recorded practice accounts from MPOs and DOTs across the nation. The second method was an online survey in which MPO respondents were asked to provide information about their current practices, procedures, methods, tools, and success rates. Finally, to provide a more detailed understanding of current practices of Texas MPOs, the research team conducted six additional on-site and phone interviews.

Task 3: Identify Best Practices and Gaps between Current and Optimal Practices

In this task, the research team analyzed the collected data to identify the most crucial areas in which procedural improvements can lead to greater success for Texas MPOs. The research team analyzed in depth the information gathered during Task 2 and determined the best practices related to cost-estimation and project scheduling. Additional analysis was carried out to evaluate the suitability of these identified best practices for application in Texas. Then, these optimal procedures were compared with existing practices among Texas MPOs to identify the most important areas for improvement. Focusing on these critical areas, the research team developed a specific list of strategies, procedures, tools, techniques, and templates that can be most effective in improving the practices of Texas MPOs. This analysis was also reviewed by an advisory panel of experts from MPOs and TxDOT districts that have a demonstrated record of success in meeting the target costs and letting dates for their projects. The research team refined the details of the analysis based on feedback from the expert panel.

Task 4: Develop the Procedural Guidebook

The research team developed a guidebook to assist MPOs in improving cost estimation and project-development timelines. The best practices and critical areas for improvement that were identified in previous Tasks were emphasized in the guidebook's creation. The process of developing this guidebook is discussed in detail in chapter 6 of this report.

Task 5: Develop the Software Tool

In this task the research team developed an Excel-based software tool to help MPOs validate their project letting dates, based on the most recent empirical data.

Task 6: Conduct a Vetting and Validation Process for the Guidebook and Software Tool

The research team verified the usability, applicability, and success of the guidebook and software tool. After the completion of these deliverables, the research team contacted two Texas MPOs (Abilene and Waco) to assist in the vetting process. The reason for choosing these two MPOs was that during the initial interviews the researchers identified that the majority of potential audiences for the guidebook would likely fall into the same population size category as these areas. The deliverables were revised to integrate the feedback that was received during this vetting process.

Task 7: Prepare the Final Research Report

To conclude the project, the research team developed a final research report (the current document), along with a brief project summary for general audiences.

Chapter 2: Literature Review

To gain a better understanding of current practices, the researchers conducted an extensive review of available literature and documentation on transportation planning processes, metropolitan transportation organizations, cost estimation, and project development timelines. The main sources of information used in this study consisted of material published or otherwise made available by MPOs from across the nation, as well as by DOTs, the Federal Highway Administration, and other transportation agencies. This chapter summarizes the findings of this literature research.

2.1. Overview of Metropolitan Planning Organizations

The necessity of harmonized transportation planning in metropolitan areas has been apparent since the early 1900s, as burgeoning cities gave rise to congestion and other mobility difficulties. However, it was not until the Federal-Aid Highway Act of 1962 that a comprehensive framework for urban transportation planning was introduced in the U.S. Since the 1960s, federal laws have mandated that all cities with a population of over 50,000 create a unified Metropolitan Planning Organization (MPO) to oversee and organize transportation planning efforts in their area (Federal Transit Administration, 2016a). In the 1980's the Federal Highway Administration further developed these requirements to stipulate that cities with a population over 200,000 must also have a formal transportation plan, an annual transportation improvement program, and a dedicated transportation planning staff (Weiner, 1997). According to the 2010 U.S. Census, over 85 percent of the country's population now lives in metropolitan areas. Sophisticated transportation planning for our increasingly crowded cities is thus more important now than ever. Figure 2.1 and Table 2.1indicate the size and location of all current Texas MPOs.

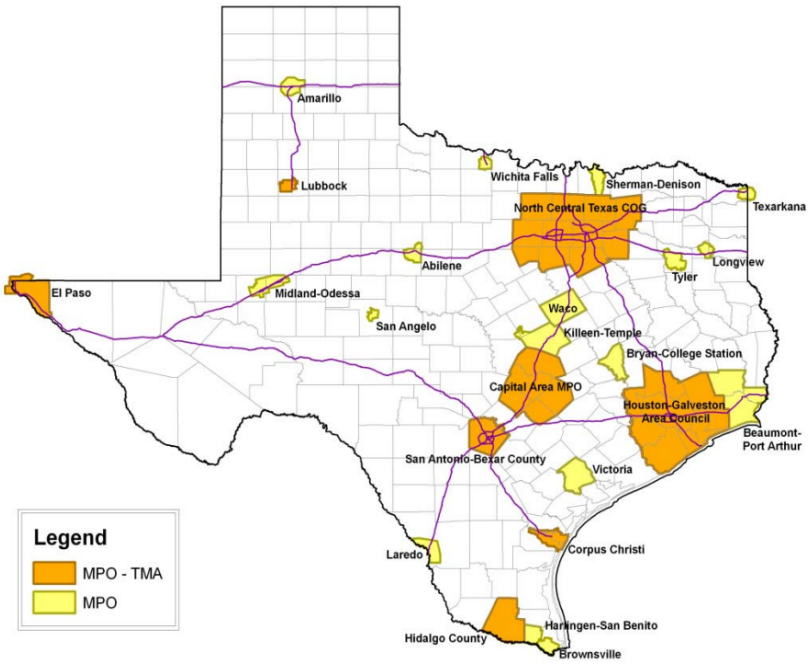

Figure 2.1. Geographic location of Texas Metropolitan Planning Organizations (Overman, et al., 2011, p. 10).

Table 2.1. Comprehensive List of Texas MPOs (Texas Association of Metropolitan Planning Organizations, 2016).

Metropolitan Planning Organization	Major City	Area in Square Miles	2010 Census Population	Designation Year
Abilene MPO	Abilene	286	126,592	1969
Alamo Area MPO	San Antonio	2,714	1,976,167	1977
Amarillo MPO	Amarillo	348	216,490	1975
Brownsville MPO	Brownsville	280	226,282	1973
Bryan-College Station MPO	Bryan	591	194,851	1970
Capital Area MPO	Austin	5,307	1,759,122	1973
Corpus Christi MPO	Corpus Christi	627	328,116	1973
El Paso MPO	El Paso	1,240	853,190	1973
Harlingen-San Benito MPO	Harlingen	364	156,063	1993
Hidalgo County MPO	Weslaco	1,584	774,014	1993
Houston-Galveston Area Council	Houston	8,466	5,892,002	1974
Killeen-Temple MPO	Belton	1,224	365,892	1975
Laredo Urban Transportation Study	Laredo	421	243,978	1973
Longview MPO	Longview	260	117,298	1975
Lubbock MPO	Lubbock	236	250,960	1976
North Central Texas COG	Arlington	9,448	6,417,630	1974
Permian Basin MPO	Midland	528	267,927	2005
San Angelo MPO	San Angelo	117	96,897	1964
Sherman-Denison MPO	Sherman	563	95,300	1980
South East Texas Regional Planning Commission	Beaumont	2,267	388,746	1970
Texarkana MPO	Texarkana	196	94,278	1975
Tyler Area MPO	Tyler	665	199,597	1974
Victoria MPO	Victoria	890	86,793	1982
Waco MPO	Waco	1,061	234,906	1974
Wichita Falls MPO	Wichita Falls	167	109,139	1975

Core Functions of MPOs

Under federal law, MPOs are required to oversee all major urban transportation projects, verify that these projects are consistent with federal environmental legislation, and ensure that the projects are carried out in a financially responsible manner. The Federal Highway Administration's *Transportation Planning Process Briefing Book* (Federal Highway Administration, 2015, pp. 4–5) lists several core functions of MPOs:

1. Facilitate fair and effective regional decision-making for metropolitan areas.
2. Determine and assess transportation improvement alternatives.
3. Develop a long-range transportation plan for the metropolitan area and update this plan regularly. The long-range plan should cover anticipated improvements for at least the next twenty years.
4. Develop a short-range plan consisting of more detailed analysis of upcoming items taken from the long-range plan.
5. Establishing performance targets in coordination with the state department of transportation, and ensure that the urban transportation plan achieves these targets.
6. Engage with the general public and provide clear and transparent information to all who are significantly affected by the transportation decision-making process.

MPO Planning Documents

There are four major transportation planning products that MPOs are required to develop by the federal government. These document types are summarized in Table 2.2., and are discussed in more detail in the following paragraphs. In addition, Texas MPOs are required to contribute to the state's Unified Transportation Program, which is also described in more detail below.

Table 2.2. Federally Required MPO Transportation Planning Products (Federal Highway Administration, 2009, p. 8).

Product	Developed by	Approved by	Time Horizon	Planning Content	Update Requirements
Metropolitan Transportation Plan (MTP)	MPO	MPO	20 Years	Future Goals, Strategies, and Projects	Every 5 Years
Transportation Improvement Program (TIP)	MPO	MPO and State Governor	4 Years	Transportation Improvements	Every 4 Years
Unified Planning Work Program (UPWP)	FHWA, FTA, and MPO	MPO	1 to 2 Years	Planning Studies and Tasks	Annually
Public Participation Plan (PPP)	MPO	MPO	As Needed	Procedures and Strategies for Engaging the Public	Periodic Review and Update

Metropolitan Transportation Plan (MTP)

The Metropolitan Transportation Plan is the MPO's long-range plan, covering a time horizon of no less than 20 years. This plan must be reviewed and updated at least once every 4 or 5 years, depending on the location area (4 years in air quality nonattainment areas, and 5 years in attainment areas). The MTP defines how the planning organization intends to develop an integrated, multimodal transportation system (including all modes of travel: transit, highway,

bicycle, pedestrian, etc.) to meet the region's transportation goals and provide for a safe and efficient movement of people and goods (Federal Transit Administration, 2016b).

Transportation Improvement Program (TIP)

The Transportation Improvement Program is a short-term planning document that covers a time horizon of about 4 years. The TIP may include more far-reaching analyses beyond 4 years, but such long-range components are considered to be provisional/informational. Most MPOs update their TIP every year, though it is also possible to wait for up to the full 4 years before providing an update. The projects included in TIPs are approved at the local level and then by the state Transportation Commission for inclusion in the Statewide Transportation Improvement Plan (STIP), which is in turn approved by the Federal Highway Administration and the Federal Transit Administration. For each planned project, the TIP provides the following information (U.S. Government Publishing Office, 2016):

1. Description of the project or its current phase.
2. Total project cost.
3. Proposed amount of federal funding.
4. Identification of the agencies that are responsible for implementing the project.

Unified Planning Work Program (UPWP)

The Unified Planning Work Program is a description of the urgent priorities, tasks, and duties that the MPO has to accomplish to develop and support their transportation plans. In this document the required resources, resulting products, schedule of activities, and responsible parties for each task are indicated. The planning horizon for this document is one to two years, and it is reviewed and approved annually (Federal Highway Administration, 1999; Colorado Department of Transportation, 2012, p. 9).

Public Participation Plan (PPP)

Transportation planning, and the implementation of the projects identified in such plans, can have a significant impact on the lives of those who live in the affected areas. Federal laws require that MPOs engage the public in the planning process and provide opportunities for members of the community to participate, consult, and/or gain awareness about the MPO's transportation agenda. To accomplish this purpose, MPOs are required to develop a Public Participation Plan. The PPP itself must be developed with a 45-day public review and commenting period (Federal Transit Administration, 2016c). Successful public participation is a continuous process, consisting of activities and actions that allow stakeholders to learn about and influence the decisions that affect their lives (Federal Highway Administration, 2016).

Unified Transportation Program (UTP)

Texas MPOs are required to contribute to the state's Unified Transportation Program, under the auspices of TxDOT and the Texas Transportation Commission. This document contains the state's 10-year transportation plan, and it is updated and approved annually. The UTP is

considered a transitional path linking TxDOT's long-term goals and agency mission to specific short-term project-level implementations. It includes any specific activities that have been initiated and are in current development (Texas Department of Transportation, 2016).

2.2. MPO Structure and Governance

Transportation planning is an iterative, performance-based process that begins with setting the transportation vision and goals, and ultimately leads to specific construction, maintenance, and operational activities (Figure 2.2). During this process multiple decision-making agencies, operator agencies, and stakeholders are involved. The participants in the process include MPOs, state departments of transportation, local governments, transit operators, members of the public who use the system, and other members of the community who are affected by transportation construction and activities.

Local urban transportation planning is led by MPOs, but it is a collaborative process supported by broader governmental agencies as well as private contractors and workers. It includes many components, not the least of which is the research and analysis that provides insight into developing travel patterns and safety demands.

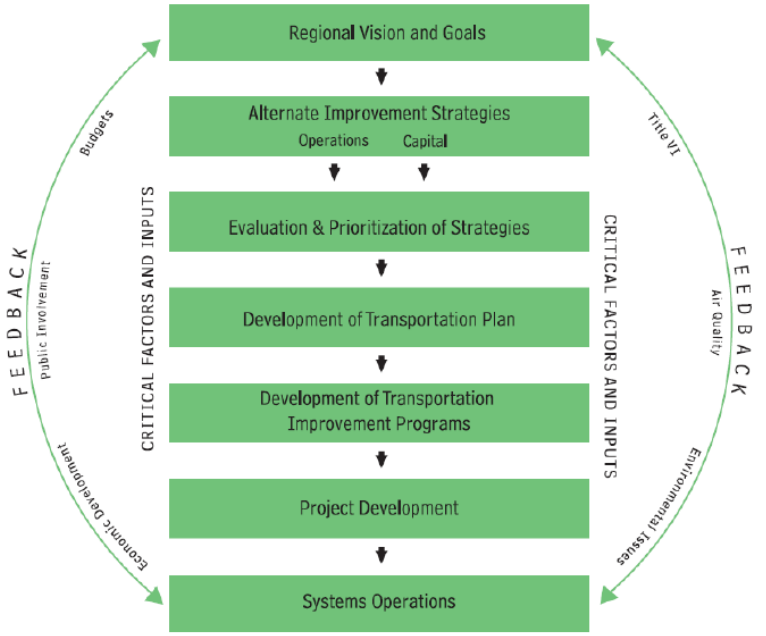

Figure 2.2. The transportation planning process (Federal Highway Administration, 2015, p. 2)

There is no required organizational structure for MPOs, but they often include a director, an executive/policy board, various technical committees, citizen advisory committees, and a general staff. Some MPOs are organized under the auspices of a larger metropolitan agency or "host," whereas others operate as fully independent entities. Many MPOs exist somewhere along the spectrum between "hosted" and "independent," as indicated in Figure 2.3. The different types of MPO organizations shown in Figure 2.3 are described in more detail below.

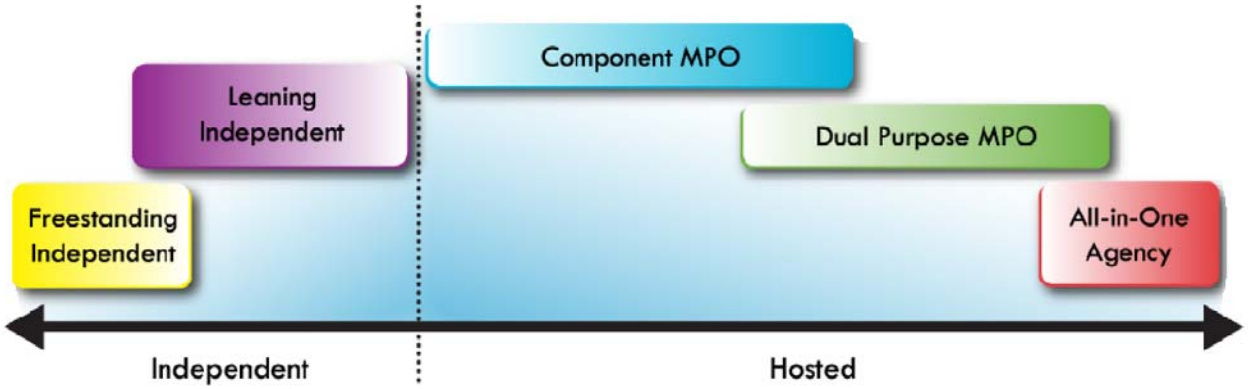

Figure 2.3. MPO hosting structures (Federal Highway Administration, 2010, pp. 3–18).

All-in-One Agency

This type of organization performs MPO functions as well as non-MPO functions. Some of its characteristics are:

- The MPO can operate under the host agency name.
- The same board governs the entire agency including the MPO staff.
- Agency staff may work on both MPO and non-MPO activities.
- The MPO is an integrated part of a Regional Council.

Dual-Purpose MPOs

In this organizational structure, the same transportation planning staff works for the MPO and for the local (generally county-level) government. These types of MPOs are often found in smaller municipal areas. Some of their characteristics are:

- The staff can work on both MPO projects and local government transportation projects.
- The MPO is officially hosted by a local government agency, but its policies are determined by a separate MPO board.
- The MPO board is composed differently than the host board, but it is included within the same agency; the MPO director reports directly to the host government agency.

Component MPOs

In this type of organization the MPO staff is completely separated from the host governmental agency, but still reports to the host agency. Unlike the previously discussed structures, staff members in Component MPOs work solely on MPO projects and they are not integrated into the larger activities of the host agency. This is the most common organizational structure among MPOs. Some of its characteristics are:

- The MPO director reports to a host agency, but the MPO's policies are determined by a functionally autonomous MPO board.
- The MPO director and staff work only on MPO projects, not on other, non-MPO projects of the host agency.

- Even though the MPO reports to a host agency, it typically works under a different organizational name than the host agency.

Leaning-Independent MPOs

In this type of organization the MPO generally functions as an autonomous agency, but may rely on local government support for items such as employee benefits packages, administrative/policy resources, equipment, or fleet vehicles. Generally the Leaning-Independent MPO will negotiate for such support under a severable contract. Some characteristics of this type of MPO are:

- The MPO board operates independently to supervise the MPO staff and activities.
- The MPO manages its own payroll, purchasing, and finances.
- Local government may assist the MPO with administrative or material resources, but this support is negotiated contractually and can be terminated by the affiliate agency.

Freestanding Independent MPOs

These MPOs hold full responsibility for meeting their own operational needs, and they make all of their own decisions without reporting to any host or affiliated agency. This is the most expensive type of MPO structure from an operational point of view. Some of its characteristics are:

- The board of the MPO operates with full decision-making autonomy and supervises its own staff.
- The MPO manages all of its own payroll, purchasing, and other financial-related issues.

2.3. The Cost Estimation Process

Accurate cost estimates are vital for the success of long-range transportation planning. The goal is to deliver the most accurate estimate possible considering the available resources and the extent to which the project has been defined. The procedures involved in cost estimation can become rather complex because of the large number of unknowns that estimators should consider, especially during the early phases of the project development process. In addition, transportation plans are usually comprised of multiple ongoing projects and sub-projects, each of which can affect the implementation and outcomes of the others. As MPOs approve new projects or sub-projects, they have to be integrated into the overall planning framework and budgeting. Thus, MPOs must endeavor to develop their plans and cost estimates based on a good understanding of each project's scope and scheduling, in order to avoid potential cascading effects that can be detrimental to the planning framework as a whole (Goetz, 2002). The way in which project estimates are integrated into short-term and long-term transportation planning is illustrated graphically in Figure 2.4.

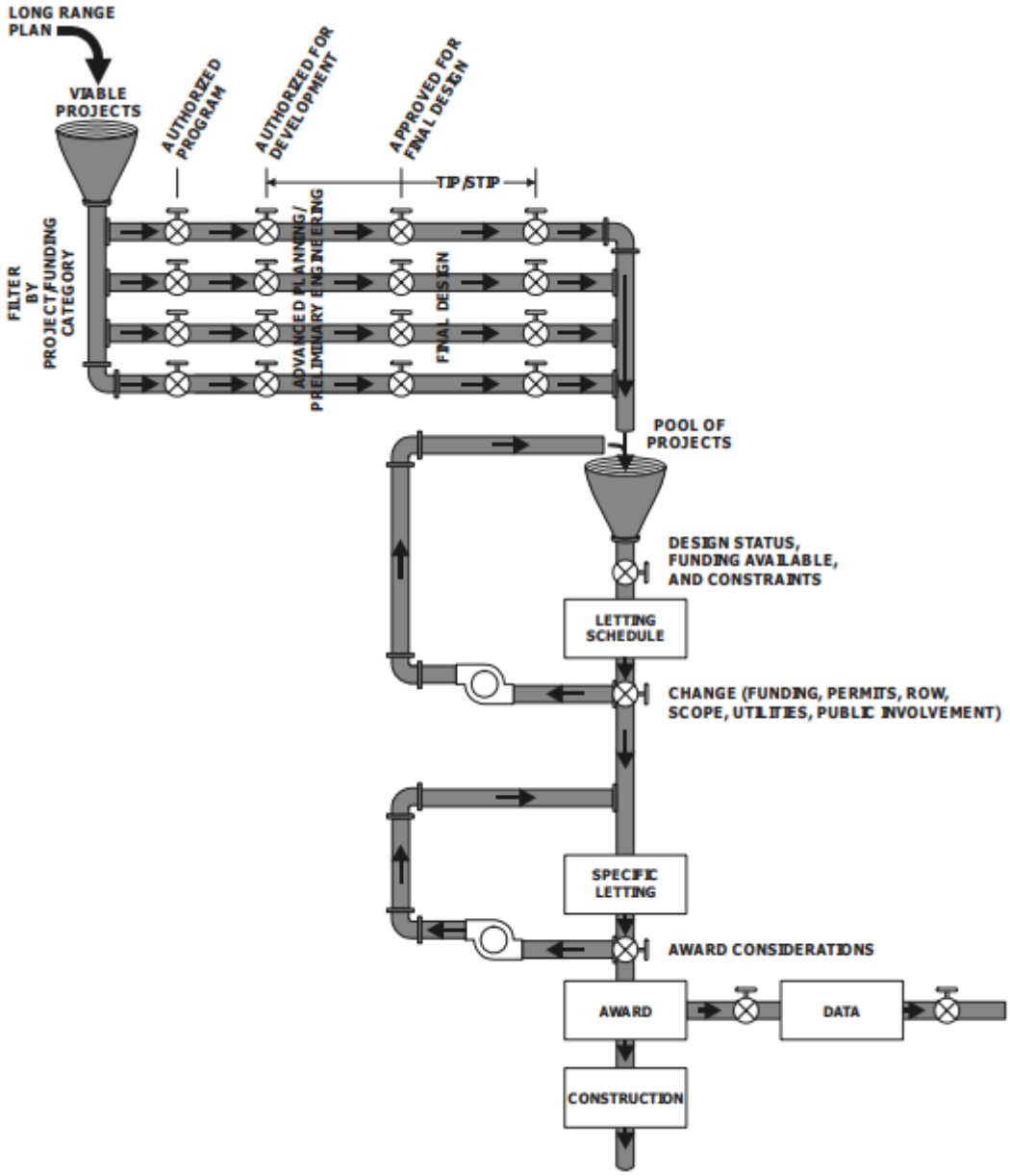

Figure 2.4. Integrating individual projects into overall transportation planning (Anderson & Blaschke, 2004, p. 11).

If the relevant projects characteristics are not estimated accurately enough, then several issues may occur over the long run. Changes in the project's scope can lead to significant cost overruns and delays. Even simple miscalculations of item pricing and timelines can have a serious effect. In some cases, cost escalation may reach such an extent that it creates serious budgetary issues, and a lack of funds can even result in the cancelation of projects that have already been initiated. As the scope and complexity of transportation project management has increased over time, problems with inaccuracies, delays, and potential cascading effects have also increased. This issue is a growing concern for both MPOs and DOTs.

Several attempts have been made by DOTs to improve the accuracy of their preliminary cost estimates. These efforts are mostly focused on developing procedural guidebooks and computer tools to help verify estimates. Table 2.3 lists some of the most significant available resources in this area. A review of this table demonstrates that no previous efforts have been made to develop a scoping guidebook that is tailored to MPOs' specific project needs.

Table 2.3. List of Prominent Cost-estimation and Project Scoping Resources.

Title	Publisher	Year
Highway Project Cost Estimating Methods Used in the Planning Stage of Project Development	Virginia DOT	2001
Cost Estimating	Illinois DOT	2002
Project Development Manual	New York DOT	2004
Guide to Risk Assessment and Allocation for Highway Construction Management	FHWA	2006
Project Development and Design Guide	Massachusetts DOT	2006
Transportation Management Plans	Maryland State Highway Administration	2006
NCHRP Report 574	Transportation Research Board	2007
Cost Estimation and Cost Management Technical Reference Manual	Minnesota Department of Transportation	2008
A Practical Guide to Estimating	AASHTO	2009
FHWA MT-08-007 8189	FHWA	2009
Highway Project Cost Estimating and Management	Montana DOT	2009
Project Development Procedures Manual	California DOT	2009
Construction Cost Estimating Guide	New Jersey DOT	2010
LPA Consultant Guide to Developing Construction Plans	Alabama DOT	2010
Project Risk Management	Washington DOT	2010
Risk Management Guidelines	Michigan DOT	2010
AASHTO Practical Guide to Estimating	AASHTO	2011
Connecticut Preliminary Cost Estimating Guidelines	Connecticut DOT	2011
Preliminary Engineering Cost Trends for Highway Projects	North Carolina DOT	2011
Project Development Manual	Kansas DOT	2011
Office of Estimating Guidelines, Procedures, & FAQ	Ohio DOT	2012
Planning Level Cost Estimation Manual	Washington DOT	2012

Title	Publisher	Year
Procedures and Models for Estimating Preconstruction Costs of Highway Projects	Oregon DOT	2012
Project Manager Handbook	Georgia DOT	2012
Risk Management and Risk-Based Cost Estimation Guidelines	Nevada DOT	2012
Indiana Design Manual	Indiana DOT	2013
Project Delivery Manual	Louisiana DOT	2013
AASHTOWare Project Cost Estimation Manual	New Jersey DOT	2014
Estimating Manual	Pennsylvania Department of Transportation	2014
Local Government Road Fund Project Handbook	New Mexico DOT	2014
Preparation Guidelines for Project Development Cost Estimates	California DOT	2014
Risk-based Construction Cost Estimating Reference Guide	Texas DOT	2014
Bureau of Design and Environment Manual	Illinoi DOT	2015
Cost Estimating Manual for Projects	Washington DOT	2015
LPA Manual for Federal-Aid Projects in Alabama	Alabama DOT	2015
Project Cost Estimation Manual	Nevada DOT	2015
Risk-Based Engineers Estimate	Minnesota Department of Transportation	2015
A Guide To Federal-Aid Programs And Projects	FHWA	2016
Cost Estimating Guideline	New Jersey DOT	2016
Hawaii Road Usage Charge Demonstration	Hawaii DOT	2016
Plan Development Process	Georgia DOT	2016
Project Development Manual for Local Public Agencies	Michigan DOT	2016

The most rigorous procedural guidelines for estimating costs and scheduling tend to be based on a five-step process: (a) determine the basis of the estimate, (b) prepare the base estimate, (c) analyze risk and set contingencies, (d) conduct a secondary review and approval, and (e) clearly communicate the estimate and contingencies to all stakeholders. This basic procedural outline is followed by the *AASHTO Practical Guide to Estimating* (American Association of State Highway and Transportation Officials, 2013), the *NCHRP Report 574* (Anderson et al., 2006), and various individual DOTs, including TxDOT in its recently released *Risk-Based Construction Cost Estimating Reference Guide* (Anderson, 2006; Molenaar, 2011). The five steps of this procedure, as discussed by Anderson (2006), are worth describing in detail.

Step 1: Determine the Basis of the Estimate

To develop an accurate overall cost estimate, the foundation must first be laid by clearly defining the scope and stages of the work, the site characteristics, and any other project determinants that may affect cost and scheduling. In this step, these project characteristics are carefully elaborated and documented, to whatever extent is possible at the current point in the project development process. All assumptions that were made about the project development should be identified.

As part of this step the estimators may identify alternative development paths. The cost estimate of the project is defined for the main development alternative, and then the change in cost that will occur by adopting other alternatives is calculated. For gaining better knowledge of the project, the estimators may visit the future construction site or project corridor in person. If visiting the site is not feasible then aerial photos or site pictures can be used instead.

Step 2: Prepare the Base Estimate

Once all the information about the project is collected, the estimators will review this material, make their base estimates, and document their justifications. Typically, the estimate is divided up into project components, with the likely cost and timeline of each component then integrated into an overall estimate. In many cases, these initial estimates are developed before the full design details are available. This allows the estimates to be used for initial budgeting purposes, but it also means that they include a lot of uncertainty and may need to be updated later as the project develops. Various techniques can be used for the calculation of estimates, depending on the available information and its accuracy. Early estimates are often developed based on historical data related to the elements of similar projects. If enough information is available, the estimate can also rely on a more detailed examination of local conditions and market prices.

An important part of this step is to define what estimating technique is most appropriate for the project by considering the project development phase, its complexity, and the level of details available (specific estimation techniques are described in Section 2.4 below). The estimator will also identify the factors that would help to better develop the cost estimate as the project progresses. Finally, the estimator will document all the inputs, outputs, tools, and techniques that were used and any assumptions that were made in creating the estimate.

Step 3: Analyze Risk and Set Contingencies

Risk and contingency analysis is crucial for developing more accurate estimates. Through this process, project managers gain an understanding not only of the median estimate of cost and timing, but also of the potential impact of undeterminable factors and the range of uncertainty in the estimate. The risk analysis is based on elements in the project implementation that cannot be clearly defined in advance (e.g., market dynamics, supply disruptions, or the weather). The project contingencies are estimates of potential costs or delays associated with these risks. As the project development and implementation continues through time, the scope of its contingencies will gradually decrease, reflecting the smaller number of remaining uncertainties.

In this step the cost estimator will document the areas of uncertainty remaining in the project description, and determine the appropriate risk analysis method. The cost contingency is then calculated based on these identified risks. Once the contingency is calculated it is added to the base cost estimate.

Step 4: Review and Approval

The estimator's calculations should be carefully reviewed by a second party to detect any possible errors or omissions. This review should be conducted before the cost estimate is used for any decision-making purposes, and before it is released to the public. The intensity of the cost estimate review can vary depending on the project complexity and the project type. In most cases, though, it should include at a minimum a scrutiny of the estimate assumptions, verification of the cost data and completeness of the estimate basis, and reconciling with previous estimates for similar projects.

Step 5: Communicate the Estimate to All Stakeholders

In this final step, the project managers should determine the clearest and effective means for conveying the project estimates to all involved parties. Procedures should be put into place to ensure that all stakeholders understand and acknowledge this information.

Cost Estimation Tools and Practices

Software resources can be a valuable tool for verifying the accuracy of cost and scheduling estimates. Maryland, Washington, Florida, Delaware, Wisconsin, and Virginia DOTs all have some variation of computer software dedicated to this purpose. TxDOT's Houston District has also developed a software tool to help with cost estimation at the local level. The approaches used in these tools vary widely. Some are little more than databases containing historical averages for various kinds of projects, while others provide more detailed algorithms for calculating costs and scheduling based on a wide range of project inputs (Kyte et al., 2004).

The researchers' review of state DOTs found that these agencies have a wide variety of different approaches toward preparing cost estimates at the project-planning stages. For example, the Florida DOT prepares long-range plans, at a 20-year planning horizon, with integrated cost estimates primarily based on a cost per-mile format. Individual districts within FDOT are responsible for preparing cost estimates at a 5-year horizon, for which they typically use a software tool that is grounded on data from historical bidding prices. In contrast, the Minnesota DOT has no consistent approach toward preparing planning-level cost estimates; these estimates are made by the individual districts using a variety of methods that range from approximate estimates of work and material quantities, to applying historical bid prices, to calculating the costs using historical cost-per-mile tables.

2.4. Specific Cost Estimation Techniques

Cost estimation techniques for transportation projects can be divided into 5 broad classes, based on the amount of information that is available to the estimators (Table 2.4). The least precise cost

estimates, Class 5 and Class 4, are typically associated with the initial planning and programing phases of a project. More precise estimation techniques – Classes 3, 2, and 1 – become available as the project details and deliverables are finalized.

Table 2.4. Five Classes of Cost Estimation (AACE International, 2003).

Estimate Class	**Maturity Level of Project Definition and Known Deliverables** (expressed as % of complete definition)	**End Use** (typical purpose of the estimate)	**Typical Estimating Methods**	**Expected Accuracy Range***
Class 5	0% to 2%	Functional area or concept screening	Approximate cost per square foot, approximate cost per mile, parametric models, personal judgment, or analogy to other projects	L: -20% to -30% H: +30% to +50%
Class 4	1% to 15%	Schematic design or concept study	Parametric models or assembly-driven models	L: -10% to -20% H: +20% to +30%
Class 3	10% to 40%	Design development, budget authorization, and feasibility studies	Semi-detailed unit costs with assembly-level line items	L: -5% to -15% H: +10% to +20%
Class 2	30% to 75%	Control or bid/tender, semi-detailed	Detailed unit cost with forced detailed take-off	L: -5% to -10% H: +5% to +15%
Class 1	65% to 100%	Check estimate, bid/tender, or order changes	Detailed unit cost with detailed take-off	L: -3% to -5% H: +3% to +10%

* Note: The complexity level of the construction project, and the availability of applicable reference data for project costs, can have significant effects on the accuracy range of cost estimates. The +/- value given here represents the typical percentage variation of actual cost from the cost estimate after the application of contingency funds (at a 50% level of confidence).

The classes of cost estimation that are of most interest in the current research are classes 5 and 4, which generally correspond to the planning and programming phases of project development. These are situations in which there are many unknowns and the most potential inaccuracy; thus, they can benefit the most from improved analytical techniques. Class 5 estimates are conducted very early in the planning process, when the specific project deliverables are almost completely

undefined. Cost estimates at this stage are usually quick "guesses," based on personal judgment or comparison to similar past projects, or at the most based on general parametric and stochastic modeling analyses. Class 4 estimates are those conducted when the project deliverables have been slightly more defined (around 1% to 15% of the full project definition). Class 4 estimates are often used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Cost estimates at this stage typically rely on parametric and stochastic modeling with the inclusion of more detailed historical data and cost-per-unit evaluations.

The preliminary planning and scoping stages of a transportation project are generally initiated with a limited amount of information, and yet cost estimates are very important at these early stages for planning purposes. The primary methods of cost estimation at this point in the project development are *parametric*; that is, they rely on the statistical analysis of available historical data for similar projects, or for similar project components. The following paragraphs describe some of these specific techniques and their applicability.

(a) Cost-per-parameter using similar projects. This technique can provide a fairly quick cost assessment at the earliest project stages, using similar projects as a basis for calculating the total cost. Historical data is collected for very similar projects, and then these costs are adjusted according to the new location, current market prices, and any other differences that are noted in relation to the new project. In this approach, the adjustments made to translate the costs of previous projects to the context of the new project can be informal, based on the estimator's best evaluation. Often these estimates are given as a probable range, based on the variability of the historical data, so that planners can include this variability in their analyses.

(b) Cost-per-parameter using typical sections. This technique is similar to the previous one, except that the costs are broken down by typical sections of the roadway. Average historical data is gathered for similar sections and then these section costs are adjusted in an ad-hoc fashion according to any notable differences in relation to the new project.

(c) Analogous project with scoping parameters. Once the project moves into the scoping stage and its parameters are more clearly defined, it becomes possible to make extrapolations from past projects in a more precise fashion. Estimators can identify a past project that has closely similar parameters in terms of scope, complexity, scheduling, and so forth, and use this past project as a basis for estimating the cost of the new one. The accuracy of such estimates is generally greater compared to estimates that rely on historical averages of broadly similar projects. Estimators using this technique may still need to make adjustments to fit the current project definitions.

(d) Component costs. Increased project definition allows for a component-by-component analysis of materials, equipment, labor, productivity, overhead, and contractor profit margins, again based on historical data. This is a relatively complex estimation method and while it can be used during planning, it is more often used during the detailed design and bidding phase of the project.

(e) Historical-bids based. Rather than developing their own estimates of component costs, planners can track the historical trajectory of contractors' previous bids for the major items of the work. Bidding history provides an easily accessible source of data and is more inclusive than simply relying on the final budgets of previous projects. Due to its convenience and effectiveness, this technique is very commonly used. When taking this approach, it is important to have adequate data (i.e., bids drawn from multiple projects) and to obtain a frequently updated sample of bids over time.

(f) Historical percentages. This method can be used for components of the project that are not fully defined at the early stages of project development. This approach draws on historical data from similar projects that have a different size/scope, and estimates the cost of a component of the new project as a percentage of the total cost of the previous project. The resulting estimates will need to be adjusted in accordance with current market prices.

(g) Combined methods. Sometimes, to obtain the best total estimate for a project, the estimates for different project components may need to be assessed in different ways. For example, the cost of labor for a project might be easy to analyze based on available data, but the cost of materials storage might need to be analyzed based on historical percentages. When different methods are used, it is vital that the estimators clearly define and document the procedures and the reasons that they were chosen. A combined approach is more common on complex projects, and it may require the assistance of multiple estimators; therefore, clear communication is vital to ensure that commensurate practices are used and that each component's relation to the others is understood when developing the combined/total estimate. The contingency included for such projects may need to be larger than normal to account for the variances in the estimation process.

2.5. Sources of Cost Escalation

Cost overrun is a widely recognized problem in the construction industry. When developing cost estimates and performing risk analyses it is extremely valuable to recognize the common sources of this problem. The reasons why construction-project costs tend to unexpectedly increase can be divided into two categories – those issues that are internal, under the influence of the project `team, and those issues that are external, beyond the control of the project team. In the following sections each of these categories of cost escalation are considered in detail for the planning and programming phases of project development. The discussion is based on documented analyses from the research literature, and it places a strong emphasis on the factors that are most relevant to MPOs.

Cost Escalation at the Planning and Programming Phases – Internal Sources

At the planning and programming phases, the researchers have identified seven primary factors that can lead to managers underestimating project costs. These are: estimator's bias, ill-considered project delivery methods, poor scheduling, lack of appreciation for the project complexity, immature project scope, inaccurate component estimates, and inadequate contingency allocation. Each topic is discussed separately below.

(a) Estimator's bias. This factor, sometimes also known as optimism bias, is the tendency of estimators to assume ideal conditions for the project delivery. There are multiple reasons why this bias may occur, but one of the primary and often hidden motivations is the competitive pressure to get the project funded by legislative bodies. Under the assumption that less expensive projects are more likely to receive financial support, estimators may consciously or unconsciously downplay the likely costs (Minnesota Department of Transportation, 2013, p. 6.; State of Washington Joint Legislative Audit and Review Committee, 2010, p. 8). One way to address this issue is to require easy-to-track linkages between cost estimate elements and the requested budget, and then establish mechanisms to hold estimators accountable if the costs rise by a certain percentage beyond their estimates.

(b) Delivery methods. The choice of the project delivery method can contribute to cost overruns if it is not well-considered. The delivery method determines the way in which risk is divided between the various parties involved in the project (for example, between the project owners and contractors). If the party that is responsible for certain risks and executions under a given delivery method is not actually capable of handling these elements, then the project may well face unnecessary delays and expenses. In choosing the delivery method, project owners have a tendency to select the method that will lead to the fastest implementation times. However, doing so without carefully considering the feasibility of the method, given the existing project partners and their capacities, increases the risk of delivery glitches that can lead to drastic scheduling and cost escalation.

(c) Schedule changes. This can result from ill-considered project delivery methods as described above, but also from a variety of other sources. In many cases they are simply the result of poor planning, along with the determination to build cheaper and faster at the expense of reasoned analysis. When unexpected delays occur, they can have ripple effects on the rest of the project implementation and the overall project cost, for example by raising material storage expenses or labor expenses. Significant changes in scheduling can also increase project costs simply due to economic inflation.

(d) Project complexity. This factor needs to be carefully considered when evaluating the level of risk and the potential budget. The more complex a project is, the more likely something will go wrong. If the complexity is not considered as a factor, then an inappropriate amount of effort (too much or too little) may be put into analyzing the details of the project cost and scheduling. In addition, project complexity can lead to cost overruns when the project team lacks the needed familiarity with the relevant processes and implementation details. In more complex projects there is an increased risk of inadequate coordination and communication problems. Projects with higher complexity should also be treated to a more rigorous constructability review process, since there is a greater likelihood of constructability issues arising in the later phases of such projects.

(e) Project scope. The scope of the work is a crucial factor when estimating the cost of a project, and it is vital that the budget of the project should be defined based on a mature understanding of its scope (CablePulse 24, 2016). As project develops, its scope will almost inevitably tend to expand to include additional work as new options and needs are discovered, unless all such potential scope issues have been well-considered in advance. The inclusion of new project

elements is not intrinsically bad, but it can have significant negative impacts on planning, so project managers should seek to ensure that potential additions are investigated and evaluated as much as possible prior to the initial estimate. Changes in scope can occur due to lack of communication among the parties involved with the project, improper utilization of the procurement process, and inadequate analysis of the design and/or dimensions of key project items (e.g., roadways, bridges, or tunnels).

(f) Inaccurate component estimates. When the cost of individual components of a project are not evaluated correctly, it can have a cumulative effect on the overall cost estimate. The task of evaluating component costs can be somewhat complex, and proper documentation, training, and experience is necessary to ensure that individual components are priced accurately. Issues that can emerge in this regard include general accounting errors and omissions of material needs from the original plans, mistakes in calculating the quantity of needed materials, insufficient allowances for contractors or subcontractors, inadequate specifications during the planning process, and failure to accurately evaluate the future market costs of construction materials and resources. To achieve a more accurate cost estimate, the process and all of its elements should be well documented and reviewed. Component cost estimates should be prepared on a valid and well-defined empirical basis.

(g) Inadequate contingency allocation. This situation occurs when the risks and uncertainties associated with the project implementation are under-appreciated. If the project's contingency budget does not reflect the actual range of uncertainty for the project, then budget overruns can become quite likely. Inconsistent application of contingencies can also result in misperceptions about how to differentiate items that are actually covered by contingency amounts, versus items that should be covered by management reserves. Contingency covers a wide range of possible events and problems, typically to account for uncertainties in planning and preparation in the primary stages of cost estimation. Clearly defining what constitutes a contingency cost can help to clarify the needed contingency amounts and reduce the misuse of contingency funds.

Cost Escalation at the Planning and Programming Phases – External Sources

External sources of cost escalation are not controllable by the project team; however, the team still needs to account for these eventualities and devise appropriate plans in case they should occur. The researchers identified four primary external factors that can lead to unexpected cost increases during the planning and programming phases. These are: local government concerns and requirements, effects of inflation, scope creep, and unpredictable market conditions.

(a) Local government concerns and requirements. This factor can lead to cost overruns, usually by necessitating changes in the scope of the project. For example, a local government may require beautification elements or business access considerations beyond the original plans that necessitate additional work. It is vital that project planners thoroughly investigate local government regulations as early as possible during the development of the project, so as to avoid any unexpected surprises during the implementation phase. In addition, the project team should seek to create a sense of cooperation and goodwill with local residents, business owners, environmental groups, and citizens' groups, so as to help mitigate any potential conflicts.

(b) Economic inflation. This factor is a significant consideration in the construction industry. To be accurate, cost estimates should be expressed in year-of-expenditures dollars (not in current dollars). Major cost overruns can occur if this is not implemented accurately, or if the rate of inflation is underestimated. Since it might take up to several decades for a project to be completed, from the initial needs identification to the final implementation, the effects of inflation can be drastic.

(c) Scope creep. Numerous minor adjustments or expansions, which are often not formally analyzed or approved, slowly add up to result in major cost overruns. This usually occurs when there is not a strong analytical framework in place to adequately define, document, and control the project scope. As projects progress, minor adjustments are often made to accommodate perceived needs or respond to changing circumstances, for example when highway projects expand in response to unexpectedly high population growth or development. Even properly managed projects can sometimes be challenged by scope creep.

(d) Unpredictable market conditions. Fluctuations in the market can lead to significant cost overruns due to changes in the prices of materials and labor. The inherent variability/unpredictability of the market is an important factor for cost estimators to consider, and it should be included in the contingency assessment. However, even when reasonable market predictions are included, unexpected variations in either local or global markets can at times lead to uncontrollable cost escalation.

Chapter 3: National Online Survey of MPOs

The research team implemented a nation-wide, online survey of MPOs. The purpose of this survey was to help identify best practices and to uncover important areas in which Texas MPOs can seek improvement. This section provides an overview of how the survey was carried out and the results that were obtained.

The first and the most important step was to develop the survey questions. The research team needed to balance the desire to gather detailed information with the imperatives of brevity and conciseness, so as to attain maximum participation. The questions were focused on identifying the national MPOs' current project-development procedures (including methods of scope analysis, scheduling, cost estimation, and risk evaluation), and determining if the MPOs used any guidebooks or software tools to enhance their planning accuracy.

A commercial Internet survey platform was used to host the questionnaire. To help maximize the response rate, the research team consulted with an MPO to identify the most appropriate contact person in various MPO organizational structures. For larger MPOs, the survey link was sent to the staff member in charge of transportation planning, or the staff member in charge of MTP/TIP development and maintenance. For medium-sized and small MPOs, the survey link was sent to the MPO director. These contacts were made via e-mail. The contacts were informed of the research goals and asked to respond to the survey within two weeks. A reminder e-mail was sent one week before this deadline.

An initial pilot test of the survey was conducted by sending the link to the appropriate contact personnel at 20 MPOs, while also inviting their feedback on the process and the questionnaire. Five of these initial MPOs responded, and based on their feedback some minor adjustments were made to the wording of the invitation and the questionnaire. A copy of the final survey invitation letter is provided in Appendix A, and the final survey questionnaire is provided in Appendix B.

After the pilot test, the finalized invitation letter was sent to MPOs nation-wide in batches of 50 contacts at a time. The reason for limiting the number of simultaneous recipients in this way was to allow the research team to better manage any questions or correspondence resulting from the invitations. The data collected from the MPO survey was analyzed in detail, and the results are presented in the following sections.

3.1. Response Rate

Out of 358 MPOs contacted, a total number of 123 respondents opened the survey link, and 40 of these respondents went on to provide full and complete answers to all of the survey questions. While the research team was hoping for a higher effective response rate, this percentage of 11.2% responding is not incommensurate with other surveys of this nature. The response-rate details are summarized in Figure 3.1.

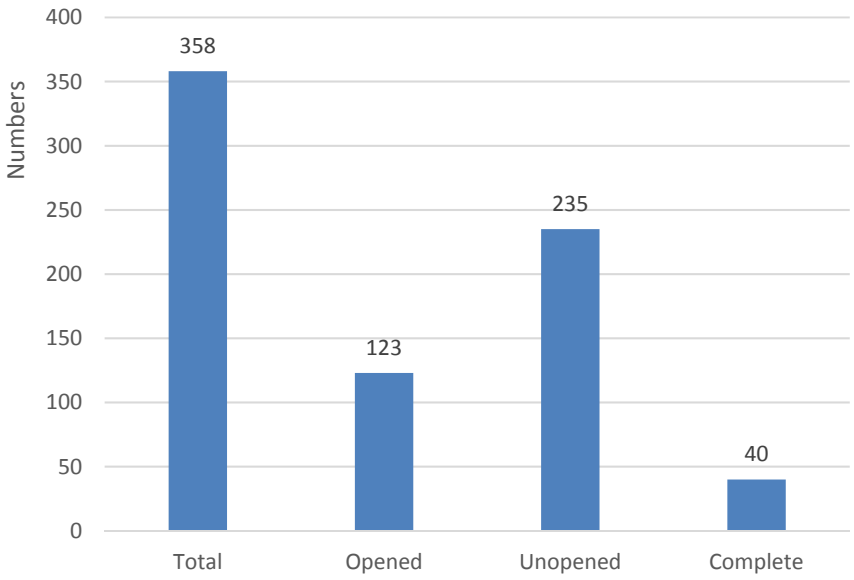

Figure 3.1. Number of survey responses compared to total number of MPOs contacted.

3.2. Analysis of Responses

Question 1. This question asked if the MPOs made use of technical tools and guidebooks in their procedures for evaluating the readiness of projects, the accuracy of cost estimates, and the feasibility of project timelines. A summary of the responses is presented in Figure 3.2. A majority of the respondents (80 percent) indicated that their MPO does not use any kind of guidebook or tool when reviewing these crucial aspects of project proposals. All of the MPOs that did indicate using a guidebook (n=8) gave specific references for these sources. The full list of guidebooks cited by the survey respondents is given in Table 3.1.

Responses	Count	Portion
No	32	80%
Yes	8	20%
Total	40	100%

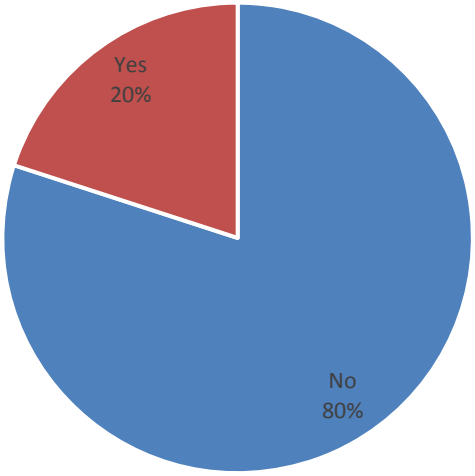

Figure 3.2. Responses to Question 1 (use of tools and guidebooks).

Table 3.1. Full List of Technical Tools and Guidebooks Mentioned in the Survey Responses.

Index	Technical Tools and Guidebooks
1	Professional cost estimates and timelines; Massachusetts DOT design guidebook.
2	Resources in the FHWA webpages.
3	Cost estimation system software; right-of-way and utility relocation cost estimation tools by Georgia DOT.
4	Florida DOT long-range estimates tables.
5	In-house cost estimation system; project deliverability guidelines for TIP project selection process.
6	Online local government guide by TxDOT; Decision-Lens software.
7	Guidelines provided by Florida DOT District One.
8	Project cost estimating tool by Florida DOT (indicated as not very accurate for the level of detail an MPO requires).

Question 2. This question asked if the MPOs had a formal process for reviewing project risks that could potentially affect the scope, cost estimate, or schedule, and for verifying risk contingencies. The summary of the responses is presented in Table 3.2. As can be seen in the table, only a very small portion of the responding MPOs had established formal processes. Forty-

two percent of the respondents indicated that their processes are informal, whereas an additional 50 percent of the sample admitted that they had no process at all for assessing risk and verifying risk contingencies.

Table 3.2. Responses to Question 2 (process for assessing risk).

Responses	Count	Portion
No process	20	50%
Informal process	17	42.5%
Formal process	3	7.5%
Total	40	100%

Question 3. The MPOs that responded to the survey were asked about their specific requirements for the level of details given in proposed project descriptions, scope statements, and cost estimates. As can be seen in Table 3.3, slightly more than half of the MPO respondents claimed to have specific requirements for the level of detail in proposals. The respondents that answered "yes" to this question were asked to provide some of their requirements. The results are listed in Table 3.4. The majority of the MPOs that indicated specific requirements described a system based on questionnaires, checklists, or similar templates.

Table 3.3. Responses to Question 3 (specific level of detail required in proposals).

Responses	Count	Portion
No	18	45%
Yes	22	55%
Total	40	100%

Table 3.4. List of Requirements for the Level of Detail in Proposals.

Index	Requirements for the Level of Details
1	Start and endpoint, clear description of the improvement, and cost estimates by the implementing agency.
2	The funding agency requirements.
3	Information for submissions provided by the state.
4	The state's Stage 0 Checklist.
5	Massachusetts DOT project need form; project information form.
6	Itemized and quantity-based information.
7	Standard details by Michigan DOT.
8	Enough description to develop scoping sketches and to allow a year of expenditures to be calculated; costs are estimated for mid-horizon and jurisdictions provide the percentage inflation.
9	Based on information found on sponsor's application.
10	Sufficient details to develop a cost estimate with reasonable confidence.
11	All project information needed to verify necessary features.
12	Predesigned project sheets, including descriptions, cost estimates, impacts, and dates of completion.
13	Specific work details, matching source info and scope; but the MPO does not evaluate the quality or accuracy of that information.
14	Feasibility analysis that fits the project scope developed by the MPO and involves a detailed cost breakdown of the project work effort.
15	Guidance and templates from the GDOT Office of Planning.
16	Internal guidelines for TIP inclusion.
17	Detailed questionnaire for TIP applications.
18	Guidelines established by FHWA and the Technical Advisory Committee (TAC).
19	Specific requirements for MPO priority applications.
20	FDOT project application form; but the MPO is still finding that significant scope and cost increases are occurring.
21	Detailed questionnaire for TIP applications.
22	Application form including project description and cost estimate; the precise level of detail included is left up to the agency submitting the application.

Question 4. This question asked about forms of outside help used by the MPOs when reviewing cost estimates. The question specifically asked if the MPO was obtaining assistance from district-level representatives from their state DOT, and/or from independent consultants. A majority of the respondents indicated that they did use some form of outside help, as indicated in Table 3.5. Among those MPOs that used outside help, there were a larger number that relied on

DOT representatives compared to those who used independent consultants. A significant number of MPOs used both forms of outside help (Table 3.6).

Table 3.5. Responses to Question 4 (use of outside help in reviewing proposals).

Responses	Count	Portion
No	10	25%
Yes	30	75%
Total	40	100%

Table 3.6. Sources of Outside Help in Reviewing Cost Estimates

Source of Assistance	Count
Independent consultants	3
DOT district representatives	13
Both independent consultants and DOT district representatives	14

Question 5. This question asked about the MPOs' procedures for preventing cost-estimate inconstancy when projects are moved from their MTP to their TIP. As indicated in Table 3.7, the majority of the respondents had no such procedures. For the few respondents that did have procedures in place, the survey asked for a summary of what procedures were used to prevent cost-estimate inconstancy. These detailed responses are listed in Table 3.8.

Table 3.7. Responses to Question 5 (procedures for preventing cost-estimate inconstancy).

Responses	Count	Portion
No	31	77.5%
Yes	9	22.5%
Total	40	100%

Table 3.8. List of Procedures for Preventing Cost-estimate Inconstancy.

Index	Procedure for Preventing Cost-estimate Inconstancy
1	Completely re-evaluate cost feasibility when moving from MTP to TIP.
2	Review costs estimates at each project stage.
3	Undertake additional project-concept development to prepare an improved cost estimate.
4	Simply compare them manually with a spreadsheet.
5	Amend TIP periodically as needed and fully update it every 4 to 5 years; consider potential cost changes from inflation and from changes to the project.
6	A price inflation factor provided by GDOT.
7	Receive the most recent cost estimate before moving from MTP to TIP.
8	Part of typical review.
9	Complete conceptual design is evaluated using responses to a fairly detailed questionnaire; local agencies are held accountable.

Question 6. The final question asked the MPO respondents to list the sources of cost inconstancy that they had experienced when moving projects from their MTP to their TIP. The answers to this question for all survey respondents are listed in Table 3.9. The responses varied, but many of them indicated deficiencies in the original cost-estimation process.

Table 3.9. Sources of Inconstancy in Cost Estimates.

Index	Sources of Inconstancy in Cost Estimates
1	Revised project scope; detailed drainage evaluation.
2	Inflation.
3	Environmental issues.
4	Local projects.
5	Preliminary cost estimates in the RTP.
6	Low MTP cost estimates.
7	Material costs; unknown levels environmental permitting; right-of-way costs; delays by utility providers.
8	Rising prices over years of a project awaiting full construction funding.
9	Poor accuracy in long-range estimates; lack of detailed design at time of applications.
10	N/A.
11	N/A.
12	Time and refinement of the project scope.
13	N/A.

Index	Sources of Inconstancy in Cost Estimates
14	Estimate method change.
15	N/A.
16	N/A.
17	Level of estimate proficiency; the need for best cost/benefit ratio.
18	Right-of-way costs; drainage issues.
19	N/A.
20	Certain elements not considered when generating the planning estimates.
21	Inflation; change in scope or detail.
22	Estimate was not accurately updated.
23	N/A.
24	Estimates review process were too informal.
25	N/A.
26	N/A.
27	Prioritization cost estimation tool is not accurate.
28	Construction cost estimates changed; right-of-way costs increased.
29	Length of time between planning and authorization; length and changing complexity of environmental process; degree of construction.
30	Planning level estimates.
31	Planning level estimates.
32	N/A.
33	Stretch out the time.
34	Funding categories.
35	Different cost estimating methods; lack of data; inflation.
36	N/A.
37	Failure to scope the project fully; failure to consider all related costs.
38	N/A.
39	Cost estimates were rough.
40	N/A.

3.3. MPO Survey Conclusions

The answers to the survey questions led to several broad conclusions that are relevant for analyzing the practices and needs of MPOs:

1. Only 20 percent of responding MPOs made use of technical tools and guidebooks. A follow-up with MPOs in Texas to determine the reasons why a majority of the MPOs do not use technical tools indicated a lack of high-quality, accessible resources that are tailored to MPOs' needs. The resources that were used by this small percentage of respondents included DOT guidebooks, resources from webpages, cost estimation software, and DOT tables.

2. Half of the responding MPOs had no process in place for reviewing risks, and an additional 42.5 percent had only an informal process. This lack of risk-review procedures could be a significant source of cost overruns.

3. About half of the responding MPOs had requirements in place for specifying the level of detail in project descriptions. These requirements were mostly based on checklists, forms, and templates produced by national and state transportation agencies.

4. The MPOs relied heavily on external assistance in reviewing project cost estimates. The majority relied on state DOT district representatives, while a smaller number made use of independent consultants.

5. The majority of the responding MPOs had no procedures in place to prevent or mitigate cost-estimate inconstancy when projects are moved from their MTP to their TIP. Those who did have procedures in place used a variety of different approaches, ranging from quick spreadsheet-based comparisons to extensive reviews of the project's design. While only 23 percent of the respondents made use of such procedures to mitigate cost-estimate inconstancy, the majority of the respondents acknowledged that their MPO had experienced at least some problems with this form of cost overrun.

Chapter 4: Interviews with Texas MPOs

The research team conducted a series of interviews with Metropolitan Planning Organizations (MPOs) in Texas, as a means of further benchmarking current practices. Detailed interviews were carried out with representatives from Texas MPOs of various sizes, ranging from service areas of fewer than 200,000 individuals to more than 6 million individuals. This chapter reports the process of developing the interview protocol and conducting these interviews, and provides a summary of the results.

The main objective in the interviews was to identify the MPOs' planning processes, their project review and assessment procedures, and their outlooks on the major tasks of the project-development process. While most MPOs have similar basic trainings and understandings of the required tasks, each organization tends to implement the planning practices in a somewhat different fashion. These local variations are not inherently problematic, and in fact it is desirable that each MPO should adapt established procedures to suit their particular needs. However, there is a high possibility that lack of rigor in the project review process, and/or excessive informality in implementing certain review procedures, may lead to potential problems and inefficiencies. In conducting these interviews, the research team was interested in understanding how each respondent organization differed from the others in terms of project development, and in identifying which project-planning tasks tend to be carried out informally.

To effectively and consistently conduct the interviews, the research team developed a protocol containing implementation instructions and a structured interview questionnaire (Appendix D). The questionnaire included two major sections: General Information and the Transportation Planning Process. The purpose of the General Information section was to identify the size of the respondent MPOs and the scale of their planning efforts in terms of the number of projects and the size of projects. This is vital contextual information since the available resources and necessary strategies for MPOs can vary significantly depending on the scale of their activities. The Transportation Planning Process section of the interview was designed to collect information in six areas, as follows:

1. The organizational structure of the MPO.
2. The overall planning and programming process.
3. The process of reviewing and assessing proposed projects.
4. The risk-assessment process.
5. The level of detail analyzed in the project scope, cost estimates, and project timelines.
6. Factors that might affect the accuracy of cost estimates.

Once the interview protocol was developed, it was filed with the Institutional Review Board (IRB) for review and approval of the protocol. After obtaining IRB approval, the research team moved ahead to conduct the interviews. First, a pilot test was conducted with two Texas MPOs to solicit feedback on the clarity of the questionnaire instructions, the utility of the included information, the method of response, and the overall format. The questionnaire package was slightly adjusted in response to this feedback, and then interviews were conducted with additional MPOs (Table 4.1).

Table 4.1. Texas MPOs that Participated in the Research Interviews.

Name	Metropolitan Area	Population (2010 Census)	Size	Interview Stage
Bryan / College Station MPO	Bryan, College Station	194,851	Small	Final
Corpus Christi MPO	Corpus Christi	328,116	Medium	Final
Houston / Galveston Area Council	Houston, Galveston	5,892,002	Large	Final
Lubbock MPO	Lubbock	245,161	Medium	Pilot
Dallas / Fort Worth MPO (NCTCOG)	Dallas, Fort Worth, Arlington, Denton, Lewisville, McKinney	6,417,630	Large	Pilot
Waco MPO	Waco	234,906	Medium	Final

4.1. Interview Process

The interviews were conducted either in person or by phone, based on the preference of the participants. The interview questions were also sent to respondents in writing prior to conducting the verbal interviews, so that the participants could take time to collect information and prepare notes as needed. Each interview began with an introduction of the project in order to explain the purpose of the research and to help put the participants at ease in regard to the research goals.

The interviews were conducted in a semi-informal setting to help make the participants more comfortable; however, the facilitators were instructed to adhere to the protocol and to the structured questions as much as possible. Each question was read out loud and the participants were asked if the question was clear for them. After signaling that an answer was complete the facilitator asked once if the participant would like to add any additional information about that topic. If the facilitators deemed necessary, follow-up questions were asked to capture additional details or to provide clarification. After finishing all of the questions, the facilitators asked the participants if they would like to provide any general comments beyond the topics that had already been covered. At the end of the interviews, the facilitators thanked the participants for their contribution to the study. Two weeks after the interviews, the transcribed responses were sent to the participants for their review and validation, providing one final opportunity for additional comments.

4.2. Interview Results

One of the issues that became apparent during the analysis of the interview data is that Texas MPOs are very diverse in their organizational structures and in their assignment of responsibilities. As would be expected, different sizes of MPOs vary considerably in the

formality of their procedures. Due to the extent of the diversity that the researchers encountered it would be unwise to fully generalize our findings from the interviews to all Texas MPOs. However, the interviews make for a good starting point in understanding some of the varied operating practices that are currently occurring in the state.

Q1. What is the organizational structure of your MPO?

The organizational structures of Texas MPOs are diverse but they generally follow one of the types described in the literature review (Chapter 2, Figure 2.3). Structures that the researchers encountered during the interviews include Dual-Purpose MPOs, Component MPOs, Leaning-Independent MPOs, and Freestanding Independent MPOs. One interesting structural fact revealed during the interviews was that none of the MPOs, of any size, had a full-time professional engineer on their staff. This means that the MPOs did not have the internal capacity to evaluate submitted projects from an engineering point of view. Instead, the MPOs used a variety of approaches to make up for lack of expertise in this area when they felt it was needed, often obtaining help from TxDOT district representatives or city engineers. Independent consultants were used only rarely in the review process.

Q2. Describe the process of developing a Metropolitan Transportation Plan (MTP) and a Transportation Improvement Plan (TIP) for your agency.

Almost all of the interviewees indicated that their MPOs were taking steps in the direction of performance-based planning in their MTP development. However, there was a lot of variation in the extent to which they used formal performance measures. Instead, the main direction of this effort was toward policy-driven planning. Some MPOs put out open calls for proposals periodically, but most relied on planning agendas developed through their MTP. One of the interviewed MPOs had two parallel processes for reviewing proposals—one process for projects submitted through TxDOT, and another for projects submitted through local governments.

In regard to moving projects from their MTP to their active TIP, the interviewed MPOs again had widely differing policies and approaches. Some of the smaller MPOs simply relied on the recommendations of their TxDOT district representatives to evaluate the level of project development that indicated a project was ready to be considered for the TIP. In most cases the process was informal, and the majority of the MPOs did not require that projects be developed to the preliminary design stage before they were added to the TIP.

Q3. How are the projects proposed by local agencies reviewed for inclusion in the MTP and/or the TIP?

The MPOs that were interviewed had a variety of project-review criteria; these included diverse factors such as (a) potential to improve traffic congestion, (b) contributions to mobility, (c) contributions to bicyclists and pedestrians, (d) project readiness, (e) environmental benefits, (f) whether or not the project addresses Title VI/environmental justice, (g) whether or not the project improves safety, (h) whether or not the project improves connectivity, (i) the presence of matching funds from a project sponsor, and (j) contributions to the overall economic development of the community. However, none of the interviewed MPOs had rigorous

procedures in place to review the level of project development from an engineering and financial standpoint.

Q4. Do you have specific requirements or measures for determining if the proposed projects are sufficiently developed when reviewing them?

The responses to this question were mixed. In general, as noted in the previous question, the interviewed MPOs did not have any specific requirements for the level of project development. They tended to expect that the proposing entity should have undertaken rigorous design and environmental-impact studies, but none of the MPOs had a process in place to consistently and formally evaluate this project development when considering proposals.

Several of the interviewees noted that TxDOT districts would like local governments to be more involved in the project development process; however, they indicated that many of the local governments lacked the budget and resources to do this kind of project development at a sufficient level of detail. Some MPOs set incentives to encourage local governments to improve the quality of their submitted proposals. For example, one MPO declared to the local governments that a smoother transition for projects into their planning process would be provided when the projects were developed to a greater level of detail. In a similar fashion, one of the interviewed MPOs indicated that they incentivized better project development by increasing the portion of cost overruns that the local government was required to pay. Another indicated that a project would only be added to their TIP if the proposing agency provided a formal commitment to that project.

Q5. How does your organization review the proposed project description and project scope? What about the cost estimate and the project-development timeline?

None of the MPOs that were interviewed had a formal process in place to review these factors. The closest thing to a formal review was an in-house spreadsheet used by one MPO to help verify the cost estimates in submitted proposals. For the most part, the factors of project scope, cost estimate, and timeline were simply checked informally for any "red flags." Some MPOs occasionally asked their TxDOT district representatives to help them review cost estimates; however, they also indicated being uncomfortable with this practice because they felt that it might lead to conflicts of interest when competing projects were submitted by local governments and by TxDOT.

Q6. Do the projects proposed by local agencies include a risk assessment report and allocated risk contingencies?

None of the interviewed MPOs required a risk-assessment report or the inclusion of risk contingencies in the cost estimates for submitted proposals. The interviewees indicated that some local governments do voluntarily include a risk contingency in their project cost estimates, but this contingency was always a fixed percentage and was not based on risk assessment.

Q7. What items are considered during your review of cost estimates?

In this question, the researchers asked about several specific factors to see if they were considered by MPOs in evaluating cost estimates or were required in submitted proposals. First, the researchers asked about project description and project scope. The respondents indicated vaguely that these factors were considered, but admitted that they were not examined very rigorously.

Second, the researchers asked if specific categories of cost were used in project estimates (e.g., construction costs, engineering costs, utilities costs, and right-of-way costs). All of the MPOs required that submitted proposals break down costs in this fashion. The small and medium-size MPOs tended to allow a percentage of the total construction cost to define each category, while larger MPOs required that proposals estimate the cost of each component separately.

Third, the researchers asked if the MPOs checked to see if historically based price estimates had been adjusted for the time of construction, the location, and the specific characteristics of a project. The MPOs generally did consider the factor of economic inflation, and they indicated two different approaches to this topic. Some of the interviewees said that proposals were required to use year-of-expenditure dollars, and they checked to see that the proposer had indeed updated the pricing information in this fashion. Other MPOs allowed the proposers to submit costs in current values, and then the MPOs updated these cost estimates themselves to take into account inflation, based on the time-frame in which the MPOs expected the project to be completed. These MPOs used a 4% annual inflation rate, which is in line with FHWA recommendations. None of the MPOs that were interviewed considered costs in geographical terms or checked to see if the cost estimates were based on local markets.

Finally, the researchers asked again if the MPOs checked for an appropriate contingency based on risk analysis. Congruent with the answers to Question 6, none of the MPO interviewees said that they required the inclusion of a risk contingency. Some of the larger MPOs indicated that their project proposals often did include contingencies, and in this case the MPO examined them informally to see if they were reasonable.

Q8. Do you make use of TxDOT district representatives and/or independent consultants to help in reviewing the cost estimates?

The answers to this question were largely congruent with Question 5. Some of the MPOs that were interviewed did use the help of TxDOT district staff to review cost estimates, but they were a bit hesitant about the practice due to potential conflicts of interest. None of the MPOs used independent consultants directly to help with cost reviews.

Q9. Are there formal or informal procedures through which a project that is unusual in complexity, size, or importance will spark a special review process?

None of MPOs that were interviewed had any special review procedures for unusual projects. The interviewees indicated they would naturally pay more attention to the quality of a project if

it were unusually large or different from the norm; however, this was a purely informal calculation.

Q10. Are there any particular external factors that might affect the project selection process?

The interviewees mentioned a large range of extraneous factors that could potentially come into play in project selection. Many of these were political factors, but topics related to safety were also indicated by some MPOs.

Q11. If the research that we are conducting to analyze MPO project development procedures leads to a standardized guidebook or a computer software tool to help improve the process, do you think that your MPO would consider adopting such tools?

All of the interviewees expressed an interest in the research process and stated that their MPOs would be interested in considering using the products of the research.

Chapter 5: Best Practices and Gaps in Current Practice

Based on the literature review and the national MPO survey results, the researchers developed an analysis of best practices for creating metropolitan transportation improvement proposals. The research team also used the survey results and the interviews to identify critical areas in which current practices often fall short of these optimal standards.

5.1. Best Practices

The analysis of the survey and existing literature indicates that three areas play an integral role in the successful development of transportation projects. The most important element is defining the scope of the work accurately and with a sufficient level of detail. When the project scope is well-defined then it is relatively easy to obtain more accurate information leading to better cost estimates and scheduling, which are the two other main components of project success.

Scoping. A transportation project takes its shape during the scoping stage of the project development process. Insufficient project details, missing components, or unrealistic assumptions will lead to poor initial scope definition, which is one of the main sources of later cost overruns and scheduling delays. While it is perhaps inevitable that some changes to the scope may occur as the project proceeds, careful consideration at the early planning stages can keep these changes to a minimum. Unfortunately, there are very few guidance sources currently available for scoping definition in transportation projects for MPOs. The lack of effective guidelines and the absence of an established method for defining effective project scoping is one of the major challenges for improving the accuracy of early project planning. Based on the literature review and survey the research team developed an extensive chronological list of project scoping tasks, which were incorporated into the guidebook produced during this research.

Cost estimates. After scoping, the preparation of a cost estimate is the second most important factor for transportation project success. Cost estimates at early planning stages will never be entirely accurate, but for effective planning they need to be as precise and detailed as possible. Simple miscalculations of item pricing and timelines can have a serious effect. In some cases, the resulting cost escalation may reach such an extent that it creates serious budgetary issues for the MPO, and a lack of funds can even result in the cancelation of projects that have already been initiated. As the complexity of transportation projects has increased over time, problems with inaccuracies, delays, and potential cascading effects due to insufficient cost estimation procedures have also increased. This issue is a growing concern for both MPOs and DOTs.

Several attempts have been made by state DOTs to improve the accuracy of their preliminary cost estimates. These efforts are mostly focused on creating cost estimation processes, tools, and techniques. The most rigorous procedural guidelines for estimating costs are developed by the Transportation Research Board (*NCHRP Report 574*) and the American Association of State Highway and Transportation Officials (*AASHTO Practical Guide to Estimating*). Several individual state DOTs, including TxDOT, Minnesota DOT, and California DOT, have also released guidelines that are more specifically tailored to their state's local conditions. However, MPOs face a critical obstacle in that few of these cost-estimation resources are specifically and accessibly tailored to the needs of metropolitan transportation projects.

Cost estimates at the preliminary stages of project development are often initiated with a limited amount of information, and yet these estimates are very important for planning purposes. The primary methods of cost estimation at this point in the project development are parametric; that is, they rely on the statistical analysis of available historical data for similar projects, or for similar project components. When developing such cost estimates, it is extremely valuable to perform financial risk analyses and to recognize common sources of cost escalation. Some of the major sources of cost escalation include estimator's bias, ill-considered project delivery methods, lack of appreciation for the project complexity, immature project scope, inaccurate component estimates, inadequate contingency allocation, lack of awareness of local governmental concerns and requirements, failing to take into account the effects of inflation, and unpredictable market conditions. By using rigorous methods to account for these factors MPOs can improve their cost-estimate procedures and thereby enhance the ultimate success of their transportation projects.

Based on the researcher's evaluation of the best cost-estimation practices nationwide, specific recommendations and templates were developed that are tailored specifically to the needs of MPOs. These recommendations were included in the guidebook.

Scheduling. The final main factor for transportation project success is accurate scheduling. When reasonable milestones are set and resource allocation is appropriately planned around those milestones, then the project implementation will run smoothly. In contrast, unobtainable or inaccurate milestones will result in an inefficient use of resources, and may even lead to a need for re-planning or re-developing the transportation project. Scheduling problems can quickly lead to escalating difficulties in today's complex and interdependent project development environment, as a delay in one project task may prevent other project tasks from proceeding and create significant logistical breakdowns.

Detailed and accurate schedules are thus necessary to prevent significant cost overruns and delays. MPOs that are successful at effectively delivering projects tend to carefully evaluate project schedules, using some of the similar historical approaches that are used for cost estimation. The researchers developed an assessment of critical MPO scheduling concerns and incorporated these conclusions into the guidebook.

5.2. Gaps in Current Practice

In considering what information to emphasize in the guidebook that was produced during this research, the team attended to crucial areas in which there was a conspicuous divergence between optimal practices and currently existing practices. The information obtained in the interviews with Texas MPOs was particularly helpful in determining areas for effective improvement.

One of the most conspicuous issues that emerged during the research was simply that no adequate guidelines were found that could be used by local governments and MPOs for project scoping and development. A few of the surveyed MPOs were using custom templates and checklists for this purpose, but while these resources were better than no guidelines at all they generally failed to provide a rigorous and evidence-based analysis. The situation in interviews with Texas MPOs was similar, with a few of the larger MPOs using custom checklists while the

medium-sized and smaller-sized MPOs had no established methods at all for analyzing the level of definition and accuracy of project scopes. Thus, the need for better guidelines to help review and document project scope is a vital concern.

In the area of cost estimation Texas MPOs face several major challenges. The most important issue is that none of these MPOs had professional engineers on staff to help review projects from a technical perspective. Without engineering expertise, it can be very difficult to review cost estimates in the sense of ensuring that all necessary project components are included. The Texas MPOs that were interviewed also suffered from a general lack of formal guidelines and rigorous procedures for evaluating costs. While experienced planners at the MPOs did tend to check informally for "red flags" and often required component-based cost breakdowns, the procedures for reviewing these cost presentations in submitted projects were far short of the rigorous techniques encouraged by state and national organizations. The lack of guidance literature specifically tailored to the needs of MPOs contributed to this problem.

A particular concern related to cost estimation was that none of the Texas MPOs that were interviewed required the submission of a project risk analysis and the allocation of contingency funds as part of the cost estimate. This is a significant oversight, given the vast amount of uncertainty that is present during early project-planning stages and the vital need for planners to have a solid understanding of the potential range of the project's cost. Texas MPOs could greatly benefit from a more formal procedure to analyze the risks in project budgets.

In the area of scheduling, the Texas MPOs that were interviewed reported even greater informality than was seen in the area of cost estimation. While an informal review of project timelines and milestones based on an individual planner's experience may be sufficient for smaller projects, the increasingly complex nature of transportation infrastructure planning and the ongoing expansion of the state's infrastructure as the population increases means that more rigorous approaches are needed. Scheduling breakdowns can have significant repercussions in terms of cost escalation, so establishing formal guidelines and review procedures in the areas of scheduling will help Texas MPOs deliver more efficient and successful project outcomes.

Chapter 6: Development of the Guidebook

The creation of the *Project Scoping Guidebook for Metropolitan Area Transportation Projects* is described in this chapter. The purpose of this guidebook is to help local governments improve their transportation proposals by developing more accurate project scoping, cost estimates, and timelines. The use of this guidebook will also help to streamline the review process of these projects for approval by MPOs, and will ultimately assist in providing better transportation services to the public at a lower cost. The primary intended audiences for the guidebook are local governments and MPOs.

The research team made use of the conclusions from the literature review, surveys of MPOs, and targeted interviews, described in the previous chapters of this report, to identify critical areas for improvement and to create a project-development framework based on national best practices. Several Texas MPOs and TxDOT district-level planning personnel assisted in making recommendations for the guidebook and in vetting its final presentation.

The guidebook describes effective practices for preparing project proposals during the three main decision-points of MPO project development: (a) review for inclusion in the Metropolitan Transportation Plan (MTP), (b) review for inclusion in the active Transportation Improvement Plan (TIP), and then (c) entering the detailed design phase. Understanding the process in this fashion allows for a progressive and iterative development of project scoping, cost estimates, and timelines as the metropolitan transportation project moves from its early conceptualization stages through more advanced stages of planning and development.

6.1. Guidebook Outline

The research team created an intuitive outline for the guidebook, presenting a logical process that can be followed by local governments when developing their transportation projects (Figure 6.1). The components included in the guidebook were based on the team's analysis of effective practices and critical areas for improvement. Each section was carefully vetted to ensure that key topics and lessons-learned were covered at a sufficient level of detail. The guidebook outline was submitted to TxDOT as part of Technical Memorandum 3 (TM-3) and was approved.

The first chapter of the guidebook provides a concise overview of the recommended process for developing a transportation project, with a focus on major review and approval milestones. Chapter 2 provides a detailed discussion about project scoping, including an extensive chronological list of specific scoping tasks. Chapters 3 and 4 provide comprehensive discussions about developing project cost-estimates and timelines. Finally, the appendixes of the guidebook include templates that can be used for preparing project scoping reports and cost estimates, as well as checklists for MPOs to use when reviewing submitted proposals.

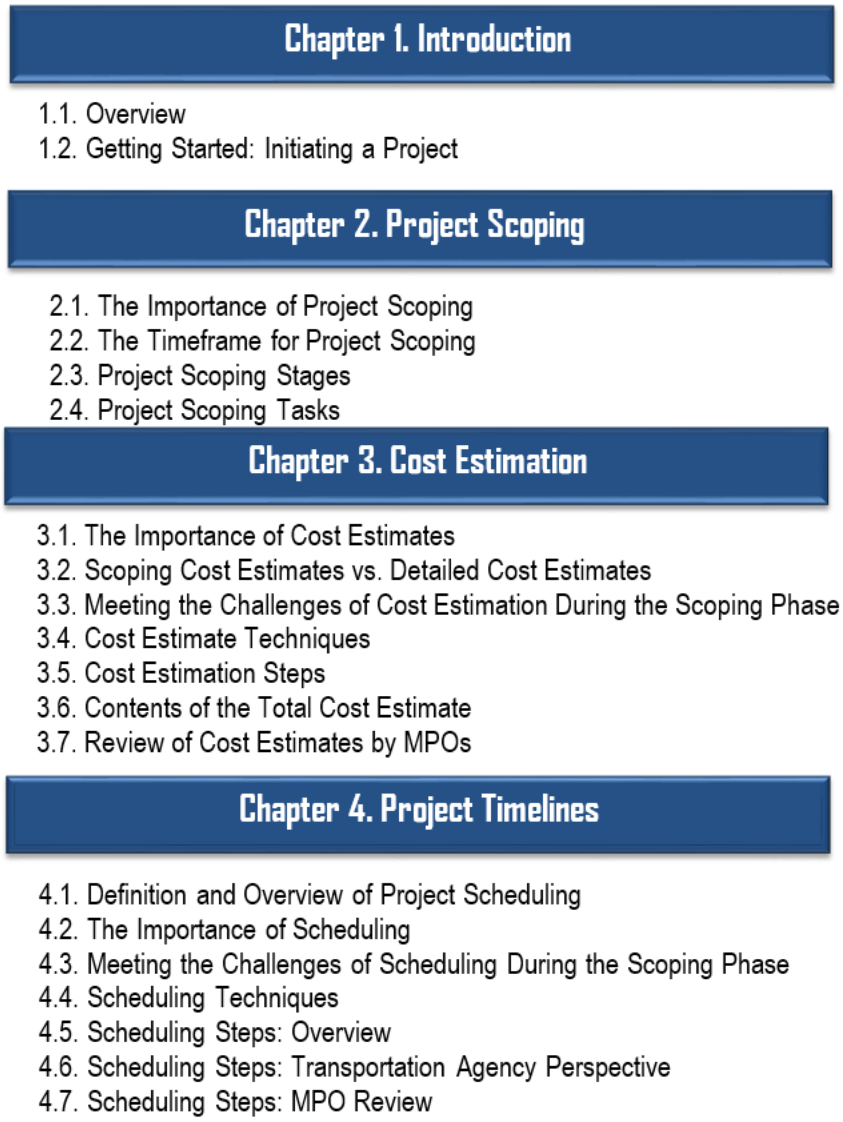

Figure 6.1. Outline of the project scoping guidebook.

6.2. Guidebook Vetting

After the initial draft of the guidebook was completed the research team implemented a rigorous vetting process to help ensure its accuracy and ease of use. Two representative TxDOT districts (Abilene and Waco) agreed to help in reviewing the guidebook and discussing its contents. The reason for choosing these two districts was that during the initial interviews the researchers identified that the majority of potential audiences for the guidebook would likely fall into the same population size category as these districts. The research team conducted meetings with personnel from the volunteer districts to review the guidebook content, and then also sent a draft copy of the guidebook to the two district planning directors for their comments. The draft guidebook was revised to integrate the feedback received during this vetting process.

Chapter 7: Conclusions

During the implementation of this research project, the team identified several important areas for future improvement. The major conclusions about future needs are presented in this chapter.

First, the research revealed that there is a significant need for more streamlined project development processes and procedures for local governments. Our study found that widespread current practices often fall short of achieving the optimal results that the best practices were able to produce. The guidebook that was created as part of this research places an emphasis on the areas that were found to be crucial for improving future success. However, local governments will still need to implement these recommendations and ensure that they are carried out successfully in order to improve their efficiency and their desired transportation project outcomes.

Second, MPOs also need to develop better internal policies when it comes to reviewing project proposals and establishing minimum requirements. As part of this process, MPOs can be a great source of guidance for local governments in helping to identify funding sources. MPOs often have vital knowledge that can help direct local governments toward the most appropriate funding to apply for based on the characteristics of their project. Good communication between local governments and MPOs is thus beneficial for all parties.

Third, the research indicated that specific training may assist in improving the project development process for both local governments and MPOs. Local governments can benefit the most from training programs that focus on the general requirements and tasks involved in successful project development. MPOs can benefit from training programs that are focused on detailed criteria for reviewing submitted proposals.

Fourth, MPOs could benefit from a greater awareness of alternative project-delivery methods. The vast majority of MPO projects are developed based on the Design-Bid-Build delivery method. However, in many cases the structure of local governments and the characteristics of their projects mean that a different delivery approach would actually be more suitable for their needs. The researchers encourage MPOs to become familiar with a wider range of project delivery and financing methods, and to work with local governments in identifying the form of project delivery that is most effective for the project at hand.

Fifth, the researchers noticed during our interviews that many MPOs do not incorporate inputs from professional engineers when reviewing project proposals. This can lead to significant oversights when it comes to evaluating a project's feasibility and the accuracy of its cost estimates and scheduling. Adding professional engineers to the planning teams (whether in-house or contracted) can enhance the quality of project scoping and make the later phases of project implementation run smoother.

Finally, local governments and MPOs should both consider the value of developing a detailed project scope, cost estimates, and timelines earlier in the planning process. A rigorous and consistent approach to project scoping, as described in the guidebook created during this

research, can greatly assist in evaluating and comparing projects and ensuring their effective implementation.

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Appendix A: Survey Invitation Letter

Enhanced Cost Estimating and Project Development Procedures for MPOs

Hello,

I would like to invite you to participate in a research study entitled "Enhanced Cost Estimating and Project Development Procedures for MPOs". The purpose of this survey is to identify the best practices among Metropolitan Planning Organizations (MPOs) across the Unites States.

The survey does not take long to complete, and your participation will help us to identify the best practices and share this knowledge with other MPOs. You can access the survey by clicking on the Begin Survey button below.

We appreciate your participation in this survey.

Sincerely,

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Begin Survey

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Appendix B: Survey Questionnaire

Introduction/Background
The Texas Department of Transportation (TxDOT) sponsored a research project to improve Texas MPOs' transportation planning by enhancing the accuracy of preliminary cost-estimates and proposed project letting-dates. The purpose of this questionnaire is to identify best practices among Metropolitan Planning Organizations (MPOs) across the Unites States. Once the results of this survey are analyzed and aggregated, they will be available to all participant MPOs for knowledge-sharing purposes.

Question 1
Are you aware of any technical tools or guidebooks that MPOs could use to assess the readiness of projects, the accuracy of cost estimates, and project development timelines?
1. No.
2. Yes (please explain):

Question 2
Does your MPO have a formal process in place to review project risks and verify allocated risk contingencies?
1. No, risk and contingency are not reviewed.
2. No, but risk and contingency are evaluated informally.
3. Yes.

Question 3
Does your MPO have specific requirements for the level of detail given in proposed project descriptions, project scope statements, and cost estimates?
1. No.
2. Yes (please explain):

Question 4
Do you make use of district-level representatives from your state Department of Transportation, and/or independent consultants, to help in reviewing cost estimates for proposed projects?
1. No.
2. Yes (please specify whether you make use of DOT district representatives, independent consultants, or both):

Question 5
Does your MPO have procedures in place to prevent or mitigate cost-estimate inconstancy when projects are moved from your Metropolitan Transportation Plan (MTP) to your Transportation Improvement Program (TIP)?
1. No.
2. Yes (please explain):

Question 6
If you have experienced inconstancy in cost estimates when projects are moved from your MTP to your TIP, what are the sources of this inconstancy?

Question 7

Would you be willing to allow the researchers to contact you and request further information about the responses that you provided in this questionnaire?

1. No.
2. Yes (please furnish contact information):
   Contact name:
   Phone number:
   E-mail address:

Appendix C: Full List of Survey Responses

Question 1

Are you aware of any technical tools or guidebooks that MPOs could use to assess the readiness of projects, the accuracy of cost estimates, and project development timelines?

No: 80% (32 replies)
Yes: 20% (8 replies)

Yes:

- We have a Massachusetts DOT Design guidebook and professional cost estimates and timelines.
- Various resources in the FHWA webpages, although they are limited.
- Yes, we use Cost Estimation System (CES) software as well as ROW and Utility Relocation Cost Estimation Tools that were developed by our state DOT (Georgia).
- FDOT LRE Tables.
- GDOT uses an in-house Cost Estimation System and Atlanta Regional Commission has initiated a Project Deliverability element into their TIP project selection process.
- The MPO utilize the online LG guide provide by TxDOT and we were informed about Decision Lense Software.
- Prepared/Provided by FDOT District One (Bartow, FL).
- FDOT has shared a project cost estimating tool with us but I've been told it's not very accurate for the level of detail an MPO requires.

Question 2

Does your MPO have a formal process in place to review project risks and verify allocated risk contingencies?

No, risk and contingency are not reviewed: 50% (20 replies)
No, but risk and contingency are evaluated informally: 42.5% (17 replies)
Yes: 7.5% (3 replies)

Question 3

Does your MPO have specific requirements for the level of detail given in proposed project descriptions, project scope statements, and cost estimates?

No: 45% (18 replies)
Yes: 55% (22 replies)

Yes:

- Project descriptions must have a start and endpoint, and a clear description of the improvement (number of lanes, sidewalks or bike lanes included, etc.). Cost estimates are supplied by the implementing agency – we sometimes offer technical assistance in developing these, but ultimately it is at the agency's discretion to supply solid estimates.
- We model the cognitive agency requirements.
- We have a set of information that we put together for each project to make submission to the state easier and readily available.
- Somewhat follows the state's Stage 0 checklist.
- Information contained in Massachusetts DOT Project Need Form and Project Information Form.
- Itemized and quantity based.
- Michigan has standard details used by all MPOs.

- Projects must have enough description to be mappable. Jurisdictions provide cost estimates in current year and provide their annual rate of inflation used when they estimate projects, so a year of expenditure can be calculated for programming projects. In the LRTP, costs are estimated for mid-horizon and jurisdictions provide the percentage inflation they use.
- Projects are evaluated for programming on our TIP based on this information (found on sponsor's application).
- Yes, sort of: We attempt to include sufficient detail such that we can develop a cost estimate with reasonable confidence.
- Yes we collect all project information and verify necessary features.
- Yes, we have predesigned project sheets that allow us to fill in the appropriate detail of each project as we go along. It has descriptions, cost estimates and dates of completion, ped/bike impacts, etc.
- We request specific termini, work, matching source info, and scope but do not evaluate the quality or accuracy of that information.
- We require a project application be completed that is more detailed for implementation and less detailed for planning or feasibility analysis. The MPO completes a feasibility analysis (scope is developed by MPO & FDOT) that involves a detailed cost breakdown of the project work effort.
- Generally follow guidance and templates from GDOT Office of Planning
- http://media.wix.com/ugd/5b8c10_a63a859564b34f9c887a72c806880f4e.pdf
- Not clear why an MPO would require or develop such requirements. MPOs are not implementing agencies.
- The MPO uses guidelines established by FHWA and the TAC.
- Per MPO priority applications.
- We use FDOT project application form; but we need to make improvements because we are still finding significant scope and cost increases occurring.
- Applicants have to complete a detailed questionnaire for TIP applications.
- Agencies must fill out an application form for proposed projects. This form requires a project description and cost estimate. However, the level of detail included is left up to the agency submitting the application.

Question 4

Do you make use of district-level representatives from your state Department of Transportation, and/or independent consultants, to help in reviewing cost estimates for proposed projects?

No: 25% (10 replies)
Yes: 75% (30 replies)

Yes (make use of DOT district representatives, independent consultants, or both):

- We receive Long Range Estimates from DOT staff, and utilize independent consultants to assist us in inflating the costs to the year of expenditure for long range projects.
- Both.
- We use our Division Project Engineers.
- District engineer sits on technical and policy committee.
- We rely on information both from our DOT and the design consultants working for communities to develop project cost estimates.
- DOT representatives and consultants.
- DOT District Office and Central Office staff prepare cost estimates for projects on DOT-owned facilities. Municipal engineering staff prepare cost estimates for projects involving municipal-owned facilities.

- We work very closely with our State DOT.
- Consultants prepare estimates for us, or we do them in-house.
- District level DOT staff review project funding applications and scope.
- We have used both.
- DOT.
- Both.
- We sometimes use DOT unit costs to estimate project costs.
- Both.
- Mostly DOT. Consultants typically only when we are preparing our regional transportation plan.
- Yes. We work very closely with our District Engineers. Jurisdictions often use consultants to generate their project.
- Yes, we use both the state DOT as well as consultant teams.
- The requirements for developing estimates are developed with FDOT and each feasibility study is reviewed and approved by FDOT before finalized.
- DOT Reps.
- District Representatives and the Technical Advisory Committee, which consists of the engineers from each of the larger cities.
- We have primarily used independent consultants to help develop cost estimates.
- Both
- Consultants.
- Rely on state DOT and local government estimates.
- State DOT office.
- District representatives.
- Both.
- Both.
- FDOT reviews all MPO submittals. Some of our member entities hire consultants to produce project descriptions and cost estimates, some do it in-house.

Question 5

Does your MPO have procedures in place to prevent or mitigate cost-estimate inconstancy when projects are moved from Metropolitan Transportation Plan (MTP) to your Transportation Improvement Program (TIP)?

No: 77.5% (31 replies)
Yes: 22.5% (9 replies)

Yes:

- Every time we amend our LRTP, we re-evaluate its cost feasibility. In addition, project costs are reevaluated when they move from the MTP to the TIP, but the implementing agency.
- Review costs estimates at each stage.
- Sort of: When we TIP a project, we've undertaken some additional project concept development that generally enables us to prepare an improved cost estimate.
- We simply compare them manually with a spreadsheet.
- We amend our TIP periodically as needed and do a full update ever 4-5 years. Costs can change from inflation, project changes, etc. Costs are then updated.
- We use a price inflation factor provided by GDOT.
- We contact the sponsor of the project to receive the most recent cost estimate before the project is moved from the MTP to the TIP.
- Part of our typical review.

- Projects moving into the TIP have usually completed conceptual design and have to be supported with responses to a fairly detailed questionnaire. Local agencies are held accountable if TIP project cost estimates are off because the jurisdiction has to make up any difference between cost estimate and expenditure in order to complete the project in a timely manner.

Question 6

If you have experienced inconstancy in cost estimates when projects are moved from your MTP to your TIP, what are the sources of this inconstancy?

- Usually it is because of a revised project scope, or additional costs that are identified because of a project moving from a conceptual plan into an actual design that includes detailed drainage evaluation.
- Inflation
- Usually environmental issues that we didn't recognize.
- Mostly local projects.
- Preliminary cost estimates are often used for projects that appear in the RTP. As more information on the project becomes available, project development begins (and perhaps the scope of the project changes), project cost estimates often change as well.
- Low MTP cost estimates.
- Material costs, unknown levels environmental permitting, higher than expected right-of-way costs, delays by utility providers.
- Usually rising prices over years of a project awaiting full construction funding.
- The accuracy of long range estimates vs. project specific design estimates. Lack of detailed design at time of applications.
- Have not experienced an inconstancy. The TIP cost estimates are generated by the DOT and are modified throughout the project development process.
- We have not experienced this.
- Time and refinement of the project scope. Our LRTP cost estimates are very high level.
- N/A
- MTP estimates have been generic, up to this point, using some standardized estimates for types of projects produced by the state DOT. Next MTP in 2018 will use a different method (which hasn't been decided yet).
- N/A
- N/A
- Level of proficiency of the project sponsors to develop these estimates, and the need to develop the best cost/benefit ratio.
- Right of way costs, drainage issues.
- See above.
- Certain elements not considered when generating the planning estimates.
- Costs usually rise either due to inflation or due to a change in the project scope or detail.
- We depend on information from local municipalities regarding their estimated costs and they don't always update that estimate after it has been entered into the MTP and TIP. The problem is much larger with state funded projects.
- N/A
- We informally review estimates in the MTP/LRTP against actual projects when they are programmed and have found the MPO estimates to be reasonable. The FDOT estimates of SIS projects however seem to vary dramatically.
- None.

- We have not had a problem with it thus far.
- Prioritization cost estimation tool used by the state DOT is not as accurate as the cost estimates done in the planning phase.
- Construction cost estimates have been too low, and insufficient right-of-way cost information.
- Length of time between project planning and authorization, length and changing complexity of environmental process, degree of construction activity in the region.
- We typically have higher estimates in the MTP because they are planning level estimates. Once moved to the TIP, and the project is designed, the costs normally become more accurate and project costs decrease. The MTP costs typically have contingencies built in to the estimate.
- Planning level estimates in mtp vs. engineered/final design level estimates.
- No experience.
- Costs are usually higher thus stretching out the time it takes to complete.
- Funding categories.
- The use of different cost estimating methods, a lack of data, or the over inflation of contingencies and estimates.
- Too broad of a question ....
- failure on the part of submitting agency to scope the project fully and failure to consider all related costs when producing estimates. We plan to hold project development and cost estimating workshops in the coming year to develop a better vetting process.
- Projects have had a greater amount of scrutiny and have completed at least a conceptual design when moved into the TIP.
- Cost estimates for projects in the MTP are, generally very rough. By the time a project is included in the TIP, the cost estimate has been refined.

Appendix D: MPO Structured Interview Questionnaire

INSTRUCTIONS

This interview is designed to be conducted in person or by phone. The interviewer shall follow the following protocol:

1. The questionnaire shall be sent to the participant one week prior to the interview, and the interviewer shall receive an e-mail from the participant acknowledging receipt of the questionnaire.
2. The interviewer shall send a reminder e-mail to the participant two days before the interview. A copy of the questionnaire shall also be attached to this e-mail.
3. In the e-mail correspondence, the participant shall be encouraged to include as many members of their organization as deemed necessary in the interview to ensure that the gathered information accurately represents the organization's procedures and processes.
4. At the beginning of the interview, the interviewer shall provide a brief description of the research project, the importance of the information that is being collected, and how the information will be used.
5. The interviewer will read each question and ask the participant if the question is clear.
6. When the participant indicates that their response is complete for a question, the interviewer will ask once if the participant would like to make any further comments.
7. At the end of the interview, the interviewer will ask if the participant would like to add any additional information.
8. One week after the interview, a copy of the responses will be sent to the participant for verification of the collected information.

STRUCTURED INTERVIEW QUESTIONS

General Information:

1. City in which the participating Metropolitan Planning Organization (MPO) is located:

2. Name of the participating MPO:

3. Annual budget of the participating MPO:

4. Average number of projects in the participating MPO's Metropolitan Transportation Plan (MTP) and Transportation Improvement Program (TIP):

5. Monetary size range of projects (from $ to $):

6. Average monetary size of a typical project ($):

Transportation Planning Process:

1. Please describe the organizational structure of your agency.

2. Describe the process of developing a Metropolitan Transportation Plan (MTP) and a Transportation Improvement Plan (TIP) for your agency.

3. How are the projects proposed by local agencies reviewed for inclusion in the MTP and/or TIP?

4. Do you have specific requirements or measures for determining if the proposed projects are sufficiently developed when reviewing them?

5. How does your organization review the proposed project description and project scope? What about the cost estimate and the project-development timeline?

6. Do the projects proposed by local agencies include a risk assessment report and allocated risk contingencies?

7. Which of the following are considered during the review of cost estimates (if any):
   (a) Project description and project scope?
   (b) Specific categories of cost (construction, engineering, utilities, right of way, etc.)?
   (c) Adjustment of historical costs for the time of construction, the location, and the specific characteristics of project?
   (d) Appropriate amount of contingency allocated based on risk analysis?
   (e) Inflation rate and year-of-expenditures dollars?

8. Do you make use of TxDOT district representatives and/or independent consultants to help in reviewing the cost estimates?

9. Are there formal or informal procedures through which a project that is unusual in complexity, size, or importance will spark a special review process?

10. Are there any particular external factors that might affect the project selection process?

11. If the research that we are conducting to analyze MPO project development procedures leads to a standardized guidebook or a computer software tool to help improve the process, do you think that your MPO would consider adopting such tools?