TURNING THE PROJECT MANAGEMENT LIGHTS ON:

EARNED VALUE MANAGEMENT IN THE STATES

by

ANDREW GRANDAGE

(Under the Direction of Katherine Willoughby)

ABSTRACT

In public management, improving the ability to manage an increasingly costly, complex, and diverse array of infrastructure projects has become recognized as a priority. Effective project management strategies are critical for reducing devastating project failures, major cost overruns, and prolonged schedule delays. Yet, public management research on modern project management strategies is scarce at best, contributing to a significant gap between theory and practice. To help fill this consequential gap in the literature and bridge this divide, this dissertation provides original research on Earned Value Management (EVM) in U.S. state governments.

EVM is a project management strategy that provides an integrated solution for establishing project milestones, generating timely measures of performance, and analyzing results. Potential benefits of EVM application include early warning of project failures, cost overruns, and schedule delays, opportunity for corrective action and mitigation of risk, and more consistently delivering projects on time and budget. This dissertation examines adoption and implementation of EVM in state governments for major information technology (IT) and transportation projects.

For both project types, the same mixed methods research design is used. The design includes document review, conduct of a focus group, implementation of electronic surveys and telephone interviews, and multiple case studies. Regarding IT project management, 18 of 31 state Enterprise Project Management Offices reported current use of EVM. States that use EVM for IT projects reported several key benefits of applying the strategy, such as early warning of cost overruns and schedule delays, improved communication, facilitation of corrective action, and overall improved project delivery. However, several organizational, policy, and human capital factors were found to be decisive in realizing these benefits.

Concerning transportation project management, six of 34 state Departments of Transportation reported current use of EVM. Similar to IT, states that use EVM for transportation projects reported numerous benefits of applying the strategy in their implementation environment. Here too, multiple factors relating to organization, policy, and human capital were found to be vital for realizing benefits. The results for both project environments align closely with established EVM literature. Therefore, this dissertation provides preliminary evidence supporting use of EVM in state government.

INDEX WORDS: Public management, Performance management, Public budgeting and financial management, Capital budgeting, Project management, Enterprise project management, Earned value management, Information technology, Transportation

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ANDREW GRANDAGE

BS, University of Central Florida, 2008

MPA, University of Georgia, 2016

A Dissertation Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

DOCTOR OF PHILOSOPHY

ATHENS, GEORGIA

2020

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ANDREW GRANDAGE

Major Professor:	Katherine Willoughby
Committee:	Gene Brewer
	Robert Greer
	Tima Moldogaziev
	Andrew Whitford

Electronic Version Approved:

Ron Walcott
Interim Dean of the Graduate School
The University of Georgia
August 2020

DEDICATION

To my Mother and Father

ACKNOWLEDGEMENTS

This dissertation is grounded by practitioners who contributed to this study by participating in a focus group, completing electronic surveys, engaging in follow-up telephone interviews, and reviewing case studies. For purposes of confidentiality, I cannot name them, just as I am unable to provide direct attribution for quotations and other observations made in this study. Nevertheless, I am forever indebted to these practitioners for taking time out of their busy schedules to contribute to this original research.

Several senior analysts at the Government Accountability Office participated in a day long focus group held by the author to discuss the scope of this dissertation, literature review, research design, and data analysis. Over 40 state governments agreed to participate in this study and 65 state officers dedicated their individual time and efforts to complete the survey. A total of 19 follow-up interviews were held with state officers that completed the surveys to provide additional context on their responses. Finally, officers from several states reviewed and provided comment on case studies about their state governments. I am especially appreciative of the state officers that completed the surveys, participated in follow-up interviews, and reviewed case studies on their respective states.

I must also thank my Dissertation Chair, Dr. Katherine Willoughby, for her invaluable teaching and mentorship. I began this research under Dr. Willoughby's supervision in Spring of 2018. Since then, she has guided me in connecting this research to broader themes in public management, developing my research design, and refining the details of each chapter. I am also extremely grateful for the wisdom and guidance from other my dissertation committee members:

Dr. Gene Brewer, Dr. Robert Greer, Dr. Tima Moldogaziev, and Dr. Andrew Whitford. Each member of my committee has been a part of this research project since the Spring of 2018. Given the collective expertise of this committee in public management and policy, budgeting, and financial management, I doubt that I could have assembled a better committee to study my topic.

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CHAPTER 1

INTRODUCTION

As the new global era of megaprojects has arrived, upgrading the capabilities necessary to manage an increasingly costly, complex, and diverse set of infrastructure projects has become recognized as a priority in public management (Blair, 2015; Brown, Potoski, & Van Slyke, 2018; U.S. Government Accountability Office, 2009, 2019). To put the growth of traditional infrastructure spending in perspective, between 2011 and 2013, China used more cement than the United States did in the entire 20th century (Flyvbjerg, 2017). However, infrastructure projects are not only getting bigger and more costly, they are becoming more complex, with the emergence of large-scale information technology (IT) acquisitions as a centerpiece of government modernization. The dynamic and iterative nature of IT acquisitions has challenged traditional project management strategies that place a premium on control and predictability, with some calling for the development of more flexible approaches capable of quickly responding to change (Mergel, Ganapati, & Whitford, 2020; Sutherland, 2014; U.S. Department of Defense, 2018).

With global infrastructure spending projected at approximately $3.5 trillion annually through 2030 (Mckinsey Global Institute, 2013), and potentially over $5 trillion including IT (Flyvbjerg, 2017), the need for governments to develop effective project governance and management systems is critical to avoid the consequences of what Flyvbjerg (2017) has described as the “Iron Law of Megaprojects : Over budget, over time, under benefits, over and over again.” Regarding budgetary impacts, Flyvbjerg (2017) notes that cost overruns have been

the norm for the 90-year period for which comparable data exists, with cost overruns of 50% common for complex infrastructure projects. More collaboration has been urged between the National Academy of Public Administration (NAPA) and the Project Management Institute (PMI) to "more consistently and efficiently achieve important public purposes, save taxpayer dollars, enhance service delivery, and rebuild public trust" (Blair, 2015, p. 789). What guidance has public management theory and research provided to govern and manage the next generation of infrastructure projects?

The contracting literature has examined how governments can develop more effective contracting rules for complex acquisitions (Brown, Potoski, & Van Slyke, 2013), such as IT systems. These systems, in particular, have features critical to quality that are difficult to specify in advance and require significant investments. Research in public budgeting and financial management has identified project management as an essential stage of the capital budgeting process to ensure that projects are delivered on time and within budget (Ammar, Duncombe, & Wright, 2001; Ebdon, 2004; Jimenez & Pagano, 2012; Srithongrung, Yusuf, & Kriz, 2019). However, aside from noting potential advantages of centralized project oversight, the field is silent on modern project management strategies and tools in general, but especially so when considering potential strategies for different types of projects. Finally, the performance management and budgeting literature has emphasized agency- and program-level operating metrics, but has yet to give explicit focus to real-time capital project management indicators (Ho, 2018; Joyce, 2011; Lu, Willoughby, & Arnett, 2011; Moynihan, 2008). To fill this important gap in the literature, this dissertation provides original research on capital project management in U.S. state governments, with special attention to earned value management (EVM).

EVM is a project management strategy that provides an integrated solution for establishing project milestones, generating timely measures of cost and schedule performance, and analyzing results. The potential benefits of EVM application include early warning of cost overruns and schedule delays, opportunity for corrective action and mitigation of risk, and greater consistency in delivering projects on time and on budget. The United States Department of Defense (DoD) imported EVM from private industry in the 1960s to manage major acquisitions more effectively (Fleming & Koppelman, 2010). Since then, EVM has become a required management and budgeting tool for U.S. federal agencies, evolving to become an internationally-recognized best practice in project management (Song, 2010). As the U.S. Government Accountability Office (GAO) has noted, EVM, if implemented appropriately, can alert managers to potential problems quickly and reduce the probability and magnitude of cost overruns (U.S. Government Accountability Office, 2009). Without EVM, opportunities for corrective action are less likely, placing projects at an increased risk of cost overruns that can have devastating impacts on public budgets. For these reasons and others, EVM is often referred to in the project management community as "project management with the lights on" (Egan, 2008; Song, 2010).

At present, the academic fields of public administration, budgeting, and financial management have yet to contribute to the study of EVM[1]. This is despite its historical role in U.S. DoD acquisitions (Fleming & Koppelman, 2010; U.S. Government Accountability Office, 1997), diffusion to other U.S. federal agencies (U.S. Government Accountability Office, 2009),

[1] An electronic library search located the term Earned Value Management in a couple of public administration publications (Brown et al., 2013; Ermasova & Ebdon, 2019). However, the term was briefly mentioned in passing and not intended as the focus of study. In addition, the author conducted an informal poll at the Association of Budgeting and Financial Management Annual Meetings in 2018 and 2019. Out of approximately 35 respondents, fewer than 5 had even heard of EVM.

growing international recognition as a best practice in project management (Project Management Institute, 2011, 2017; Song, 2010), and the field's own call for better project management capabilities (Blair, 2015). A central contention of this research is that a comprehensive capital budgeting process requires EVM. Furthermore, its systematic study is needed to better understand its applicability in the public sector, especially in state and local governments, where no studies have been conducted to date. This dissertation provides original research on EVM in U.S. state governments, by examining its use by these governments for major IT and transportation projects.

Delivering IT projects on time and on budget is understood to be tremendously difficult in both the private and public sectors (Bloch, Blumberg, & Laartz, 2012; Flyvbjerg, 2017; Standish Group, 2015). For example, almost 30% of major IT projects result in failure, meaning they are cancelled before completion or fall into disuse soon after implementation (Georgia Technology Authority, 2013; Standish Group, 2015). Moreover, roughly half of IT projects experience cost overruns of greater than 50% (Georgia Technology Authority, 2013; Standish Group, 2015). For this reason, Flyvbjerg (2017) has referred to IT projects as "ticking time bombs . . . waiting to go off," as organizations, public and private, execute their strategic modernization plans. Therefore, as state governments replace legacy systems, innovate how they interact with citizens via technology, and invest in cybersecurity, effective project management strategies are needed.

This research found that, as state governments are modernizing and striving to become more efficient and accountable for results, enterprise project management offices (EPMOs) are playing an increasingly important role in selecting, planning, and managing major IT projects. An EPMO advises on the selection of major projects, issues policy standards and practice

guidance for project management, conducts oversight, maintains portfolios of major projects, provides consulting services and training, and, more generally, builds project management capacity for an organization. The EPMO concept is relatively new to project management, emerging in the last couple of decades, and has become recognized as a best practice (Kunkle, Contreras, Abba, Haase, & Pells, 2017; Project Management Institute, 2016, 2018). This dissertation examines the operations and policies of EPMOs in U.S. state governments to uncover evidence on efforts to improve the delivery of major IT projects, with emphasis given to the application of EVM.

State Departments of Transportation (DoTs) face intense pressure from elected officials, the public, and media to improve the effectiveness of project delivery for practically all modes of transportation (National Cooperative Highway Research Program, 2009). If transportation projects are not delivered on time and within budget, potential impacts range from local disruption and inconvenience to more wide-ranging safety, economic, and budgetary consequences. Transportation is the largest category of capital expenditures for state governments, comprising 64% of all capital expenditures and totaling $73 billion in Fiscal Year 2019 (National Association of State Budget Officers, 2019). In its most recent assessment, the American Society of Civil Engineers rated America's roads, bridges, and transit systems as mediocre to poor, citing significant deficiencies in conditions and functionality, with increasing vulnerability to safety risks as transportation assets approach the end of their service life (American Society of Civil Engineers, 2017). Thus, given the sheer cost of transportation projects and the existing inventory of crumbling infrastructure, the need for effective transportation project management strategies is urgent. Finally, given recent revenue shortfalls

experienced by state governments in response to COVID-19, the need to improve efficiency of capital project delivery has taken on a new level of urgency.

Having established the problem statement, knowledge gap, and consequences of this gap, the primary research questions of this dissertation are introduced below, followed by a summary of findings from each chapter.

1) Have state governments adopted EVM as a component of their IT project management strategy? Have state DoTs adopted EVM as part of their project management strategy?
2) What are the contributions to project management for major IT and transportation projects?
3) What factors promote effective use of EVM for IT and transportation projects?

Chapter 2 begins by tracing the origin of the EVM concept to the scientific management movement (Anbari, 2003; Fleming & Koppelman, 2010). It then chronicles the evolution of EVM in the U.S. federal government, relating key themes and events to public management, budgeting, and financial management literature. The historical record of EVM has key points in common with major themes of public budgeting literature. On the evolution of EVM, the dominant theme of early reforms is control; those that follow emphasized management, consistent with Schick's seminal analysis of budget reform in the U.S. federal government (Schick, 1966). The EVM experience also supports the notion that successful budget reform requires serious attention to the dynamic objectives and needs of organizations and practitioners (Forrester & Adams, 1997), in this case, project managers, by giving them the tools needed to pivot quickly to accommodate change.

The federal EVM experience is another illustration of the importance of performance information for budget execution, allowing for metric analysis to inform budget management (Ho, 2018; Joyce, 2011; Melkers & Willoughby, 2001; Moynihan, 2008). Ultimately, EVM can be considered a hidden New Public Management reform (Osborne & Gaebler, 1992), with

policymaking authority given to industry to emphasize “insight, not oversight” (U.S. Government Accountability Office, 1997). The EVM reforms aimed to establish high levels of accountability for the results of government spending while giving discretion to industry in defining management processes used to achieve results, consistent with Moynihan’s performance management ideal type (Moynihan, 2008, p. 33).

With the literature review complete, the chapter goes on to outline the research design used for the empirical chapters. To conduct this research, the same mixed-methods approach was employed for IT and transportation, using document review, a focus group, implementation of electronic surveys and telephone interviews, and multiple case studies. Regarding analysis of project management strategies, a generic top-down strategic framework was developed to provide a descriptive “state of the states.” Participating states were scored based on nominal criteria, with possible scores ranging from 0 to 7. Concerning implementation of EVM, a series of Likert scale questions were used to capture perceptions on EVM’s contribution to project management and the relative importance of several factors affecting implementation (see Figures 2.3 and 2.4). Follow-up semi-structured interviews were held with state officers to provide context on project management reforms, strategies, and EVM implementation. Finally, multiple case studies were conducted to gain a deeper understanding of the experiences of the states.

Regarding IT project management, a total of 31 state enterprise project management offices (EPMOs) responded to the survey, and 11 officers participated in telephone interviews. Chapter 3 shows that most states have taken key initial steps in executing their strategy for IT project management, such as establishing EPMOs, adopting industry standards, and defining project management guidelines. However, in 17 of the 31 states, agencies are not required to follow EPMO guidelines and are given broad discretion in how they manage projects. Eighteen

states currently use EVM for major IT projects and 13 have no plans for adoption or usage in the near future. The style of EVM practiced is based on Project Management Institute (PMI) standards. As Chapter 2 explains, PMI standards were developed to provide a simple, flexible, and less restrictive version of EVM than specified by the U.S. federal government. In comparison to the U.S. federal government, use of EVM for major IT projects in the states is relatively new, flexible, and decentralized.

Chapter 4 provides results of EVM implementation for IT project management. Findings from 17 states that currently use EVM indicate that it serves as an effective early warning system for cost overruns and schedule delays, enables corrective action, and helps meet cost and schedule objectives. However, certain factors are decisive in realizing these benefits, such as establishing an EPMO, tailoring practices to fit project context, conducting independent reviews of performance baselines, developing corrective action plans based on EVM indicators, reporting tools, and training programs. These findings align closely with the general EVM body of knowledge, especially studies of use in U.S. federal agencies.

Concerning transportation project management, a total of 34 state Departments of Transportation (DoTs) completed the electronic survey, and eight officers participated in telephone interviews. Chapter 5 provides results for the strategic framework and implementation of EVM. For the strategic framework, most states have established statewide PMOs, adopted industry standards, and defined their project management guidelines. However, in 18 of 34 states, project teams are not required to practice guidelines as specified by the statewide PMO, and are afforded discretion in choosing practices to implement. EVM is currently used in six state DoTs, four have plans for adoption in the near future, and 24 do not have plans for EVM adoption or usage in the near future.

Results from six state DoTs indicate that EVM has provided early warning of cost overruns and schedule delays, improved communication, given opportunity for corrective action, and helped project teams achieve their cost and schedule targets. Factors cited as very important for realizing the intended benefits of the practice include the establishment of a centralized office, adoption of PMI standards, independent reviews of performance baselines, development of corrective action plans based on EVM indicators, training programs, and reporting tools. Findings for transportation project management in this dissertation align with results from IT found in this study and the established EVM literature.

The dissertation concludes with Chapter 6, by summarizing findings, providing a comparative analysis of IT and transportation, explaining the contributions of this research, and describing how future work can build upon this study and avoid some of its limitations.

CHAPTER 2

EARNED VALUE AND PUBLIC MANAGEMENT

> Earned Value is a concept—the concept that an estimated value can be placed on all work to be performed, and once that work is accomplished that same estimated value can be considered to be "earned." The utility of this concept as a management tool is that the summation of all earned values for work accomplished when compared to what was actually expended to perform the effort can provide management with a comprehensible, objective indicator of how the total effort or any identifiable segment is progressing.
>
> —A.E. Fitzgerald, Earned Value Summary Guide, 1965

Before proving an historical account of the origin and evolution of EVM in the U.S. federal government, it is helpful to provide some clarity on the term itself and how the concept differs from alternative project management strategies. EVM refers to a project management strategy that provides an integrated solution for establishing project milestones, generating timely measures of progress, and analyzing results. Figure 2.1 provides alternative strategies, including information for "spend plans" and "schedule of values/percent complete." A simplified example, provided in Appendix A, illustrates how EVM dominates both approaches. EVM provides a more recognized methodology for breaking projects into smaller components than "schedule of values/percent complete" and analyzing results monthly. By doing this, it provides project managers with more timely information on project status.

Origin and Evolution of the EVM Concept

The origin of the EVM concept can be traced to the scientific management movement (Fleming & Koppelman, 2010; Kwak & Anbari, 2012). In the late 19th century, industrial engineers developed an approach to measuring the productive efficiency and timeliness of factory work. By the early 1950s, the DoD recognized that its increasingly costly, complex, and mission-critical acquisitions demanded more advanced project control and management techniques, and borrowed the concept from private industry in the 1960s (Abba, 1997, 2000; Fleming & Koppelman, 2010). For example, in monitoring costs, the use of "spend plans" simply asked contractors to report their actual costs against planned costs. These reports were mostly useless because they failed to provide an accurate measure of cost variance, something industrial engineers were acutely aware of for at least half a century prior.[2] Often, by the time problems were discovered, significant sunk investments had been made, making correction of error difficult and cancellation unlikely. As Abba explains (1997, 2000), because of the mission-critical nature of defense acquisitions and their significant investments, they tended to continue and were frequently completed at costs much greater than planned, and, in some cases, at quantities less than desired.

To manage major acquisitions more effectively, the DoD enacted reforms in the 1960s that created the foundation for modern EVM. Fleming and Koppelman (2010) have chronicled the evolution of EVM in the U.S. federal government and divided it into three distinct phases: 1) PERT/Cost, 2) Cost/Schedule Control Systems Criteria (C/S CSC), and 3) EVM.

[2] See example in the Appendix A.

PERT/Cost

The use of EVM in the public sector was motivated by an extension of the Program Evaluation Review Technique (PERT). The PERT was introduced by the U.S. Navy in 1958 as a scheduling tool, capable of representing a project network. In 1962, PERT/Cost was introduced, to expand the use of PERT to manage costs by adding resources to the scheduled activities in the project network. This allowed for projects to be decomposed into milestones with estimated completion dates and cost. Using PERT/Cost, at any given time in a project, an objective measure of the work performed could be provided to analyze schedule and cost performance. The PERT/Cost phase was short, lasting from 1962-1965. PERT/Cost was instrumental in addressing the fundamental measurement flaws of spend plans. However, DoD needed to develop broad governance and management policies for major acquisitions, leading to the next reform.

Cost/Schedule Control Systems Criteria (CSC)

Early discussions at DoD considered the development of a project control system with specific characteristics defined by the government (Fleming & Koppelman, 2010; Morin, 2009). However, two factors moved policy toward industry-defined criteria (Morin, 2009). First, a survey of the aerospace and defense industry showed clear resistance to adopting and investing in project control systems defined by the government. Secondly, contractors had been developing their own management systems, which they argued to be the state-of-the-art and worthy of emulation. Therefore, while standards were developed to promote accountability, contractors were given discretion in refining their own systems. Instead of standards defining specific and detailed practices, they identified criteria that a contractor's system would have to satisfy concerning planning, scheduling, budgeting, reporting, and data analysis. Importantly, in

defining standards, it was obvious that the spend plan approach had to be replaced, and EVM concepts were codified unambiguously for reporting cost and schedule performance. In reflecting on this reform, Lt. General Hans Driessnack from the United States Air Force (USAF) commented:

> The Earned Value concept came to us right off the factory floor, from the industrial engineers who were comparing their planned standards with earned standards and actual costs. We simply added this to our one-time only, non-recurring development tasks.
>
> —Quoted in Fleming and Koppelman, 2010, p. 28

However, contractors were given flexibility in developing internal controls and defining their project management practices. In 1967, DoD issued standards for management procedures and internal controls to ensure that major projects were properly planned, scheduled, budgeted, and reported. Specifically, Cost/Schedule Control Systems Criteria (C/S CSC, "CSC") outlined 35 criteria that a contractor's project control system had to comply with to be awarded a major defense acquisition. Other U.S. federal agencies, such as the National Aeronautics and Space Administration (NASA), Department of Energy (DoE), Federal Aviation Administration (FAA), and National Oceanic and Atmospheric Administration (NOAA) followed DOD's lead in adopting similar standards for their costly and risky contracts (Abba, 1997; Fleming & Koppelman, 2010).

The 30-year experience with the CSC era (1967-1996) illustrated that project control and management systems face stiff and competing demands from different users (Abba, 2000; Christensen, 1998; Fleming & Koppelman, 2010; U.S. Government Accountability Office, 1997). These systems must support a control function by serving the needs of oversight agencies while also supporting a management function by providing project managers with timely and

relevant information. Contractors recognized the standards as originally codified to be sound management principles but felt that CSC, as implemented, had evolved to contain too many burdensome requirements (U.S. Government Accountability Office, 1997). There was growing concern that the implementation of CSC had been hijacked by a "cultist society" (Fleming and Koppelman, 2010, p. 33) of external consultants with financial control orientations completely disconnected from the needs of project managers. Specifically, it was found that the implementation of the standards served the needs of the presiding financial management community but not those of project managers (Christensen, 1998; U.S. Government Accountability Office, 1997).

Earned Value Management

In the early 1990s, GAO found that commercial firms were increasingly adopting an "EVM concept" for their own development projects, applying it in a much more streamlined manner than exhibited by the U.S. federal government in CSC (U.S. Government Accountability Office, 1997). By focusing on more frequent and relevant measures, commercial firms were able to realize more instrumental benefits than their governmental counterparts. For example, while commercial managers were provided status on a weekly basis, those in government could wait up to 60 days after a monthly reporting period to receive such information. Commercial firms also set tolerance limits for cost variance analysis, to focus on issues needing management attention and to avoid the need to document, analyze, and explain minor deviations. In analyzing schedule data, variance analysis in commercial programs tended to focus on critical path activities, as opposed to government programs, which identified all elements.[3]

[3] Critical path activities are those that, if not completed on time, will cause a delay in the delivery of the project.

An environment supportive of reform, specifically the "re-inventing government movement" or New Public Management (Osborne & Gaebler, 1992), provided momentum for policy change. Specifically, the "insight, not oversight" philosophy of DoD acquisition reform initiatives in the 1990s (U.S. Government Accountability Office, 1997) contributed to the call for the National Defense Industrial Association (NDIA) to develop their own criteria for project control and management systems more compatible with the needs of private industry. Importantly, the next reform that emerged, in 1996, the Earned Value Management System (EVMS), intended to reach beyond the DoD, and was issued as a standard for federal acquisitions and specified as a required component of capital planning for all federal agencies.[4] The significance of the reforms was not to be found in the nature of policy; the EVM criteria remained similar to CSC (Fleming & Koppelman, 2010). Instead, the notable change was the intended manner of implementation. In contrast to CSC, which had evolved to emphasize control, the philosophy underlying EVM stressed management. In fact, the term Earned Value *Management* System can be considered a socially constructed term, intended to symbolize a departure from the mode of Cost Schedule *Control* Systems Criteria.

Another factor that contributed to the diffusion of EVM in the U.S. federal government in the 1990s was the proliferation of large-scale IT acquisitions. With practically every federal agency replacing legacy IT systems and adding new ones essential to modernization efforts, the domain of costly and complex megaprojects was no longer dominated by aerospace and defense. In 1996, Congress passed the Clinger-Cohen Act to expand oversight for the Office of Management Budget (OMB) on federal IT projects, specifically in establishing performance management systems to track progress and analyze results (U.S. Government Accountability

[4] Office of Management and Budget Circular A-11 Part 3, "Planning, Budgeting, and Acquisition of Fixed Assets," issued in 1996.

Office, 2009a). In 2005, OMB directed all federal agencies to implement EVM for "major" IT acquisitions.[5]

The United States has been the leader in driving EVM innovation globally (Abba, 2000). The practice of EVM diffused widely, with recent evidence of use in 61 countries and dozens of industries (Song, 2010). In 1995, Australia, Canada, and the United States signed a memorandum of understanding for cooperative implementation of EVM principles in defense contracting; others countries, such as Sweden, New Zealand, and the United Kingdom have participated in this international cooperation (Song, 2010). In the last two decades, contractors with EVM experience have voluntarily adopted simple and flexible versions of it for their commercial operations (Project Management Institute, 2017; U.S. Government Accountability Office, 1997).

The EVM Body of Knowledge

A comprehensive literature review was conducted to assemble the EVM body of knowledge into organizing themes. Although the EVM concept has been studied for decades, only a few attempts have been made to synthesize the literature (Fleming & Koppelman, 2010; Song, 2010; U.S. Government Accountability Office, 2009b; Willems & Vanhoucke, 2015). This section discusses key findings for three primary themes of EVM literature: reform, policy implementation, and performance measurement. The themes of policy implementation and performance measurement naturally overlap, as they both focus on EVM in action. However, for purposes of exposition, this dissertation distinguishes that implementation concerns the nature of policy and conditions supportive to effective implementation in a broad sense, whereas performance measurement emphasizes earned value measures and metrics. This section

[5] OMB Memorandum, M-05-23 (August 4, 2005). In the U.S. federal government, "major" typically refers to acquisitions of $20M or greater.

concludes by providing concise answers to the three primary research questions based on EVM literature to date: Who uses EVM? What do they get out of it? What makes it work?

Reform

The foundational literature was written by practitioners who helped facilitate significant reform in the U.S. federal government (Abba, 1997, 2000; Christensen, 1998; Christensen & Heise, 1993; Christensen & Payne, 1992; Fleming & Koppelman, 2010; U.S. Government Accountability Office, 1997). Naturally, the focus of their writing concerned reform, and the reformers have provided historical accounts of Pert/Cost, C/S CSC, and EVM. In this regard, Fleming and Koppelman's (2010) book, published by the PMI in multiple editions, is the most widely cited. The authors use literature and document review, elite interviews, and self-reflection to provide a deep understanding of the origin and evolution of the EVM concept. Their locus, and that of the other reformers, was exclusively the U.S. federal government. Song (2010) has described international reforms and explained EVM policy diffusion among national governments. However, research on reforms in subnational governments is non-existent, leaving us with a partial understanding of EVM reform in the public sector.

The previous section provided a thorough review of federal EVM reform, so the coverage of it in this section expounds on the control-management dynamic and touches on other general observations of major policy changes. Regarding the control-management dynamic, an ideal system provides sufficient control for oversight agencies and managerial flexibility to contractors. However, designing such a system is inherently difficult, because some features that improve control may not serve a management function, and in some cases, introduce wasted motion. A notorious artifact from the CSC era, the *DoD Joint Implementation Guide,* grew in size and complexity to a list of 174 questions (Christensen, 1998; Fleming & Koppelman, 2010).

This guide was originally intended to be used along with expert judgement, asking relevant questions when appropriate. However, thanks in part to the "cultist society" (Fleming and Koppelman 2010, p. 33) of control-oriented consultants, the guide was applied more comprehensively than it should have been in many instances (Christensen, 1998). This not only wasted time and money, but also left a lasting negative impression with industry, giving CSC a bad reputation.

As GAO has explained, it became widely accepted that CSC was in need of reform (U.S. Government Accountability Office, 1997). Some argued that CSC could potentially undermine performance if reporting continued to be too detailed, voluminous, and stale (Christensen, 1998). Christensen (1998) argued that the EVMS reform restored the balance between relevance for managers and reliability for auditors. That is, CSC emphasized reliability to the detriment of relevance, and EVMS was a correction that established a better balance between the two. The reform attempted to capture the managerial benefits of the "EVM concept" as realized in private industry, while reducing wasted motion from excessive controls experienced in government. All things considered, earlier project control-management reforms had a control orientation; subsequent managerial ones acted to move the system to a more ideal balance between the two.

The historical account points to certain environmental conditions supportive of policy change, such as project failures and political, legal, and technological factors. On project failures, following the high-profile cancellation of the Navy's A-12 stealth medium-bomber program, a study was conducted by the DoD using data from over 400 projects. The study found that earned value indicators reliably predicted cost-overruns once projects reached approximately 20% completion. Following the study, the DoD modified its reporting policies to require specific EVM indicators (Christensen & Heise, 1993). Concerning political and legal factors, the early

1990s generated key legislation, such as the Government Performance and Results Act (GPRA) and Federal Acquisition Streamlining Act (FASA). GPRA required federal agencies to integrate budget and performance information by developing measures and reporting on program results. FASA, enacted following the passage of GPRA, addressed performance management matters specific to acquisitions. In particular, agency heads were directed to define cost and schedule objectives for major acquisitions, and achieve, on average, 90% of their cost and schedule targets (Kwak & Anbari, 2012). As described in the previous section, the proliferation of large-scale IT acquisitions led to the passage of Clinger-Cohen Act of 1996, requiring development and use of performance metrics for these new megaprojects.

Policy Implementation

Although practitioners identified a number of flaws with the implementation of CSC, and factors critical to the EVM reform, attempts at synthesis and development of conceptual frameworks to provide a deeper understanding of implementation are lacking (Kim, Wells Jr, & Duffey, 2003). Kim et al. (2003) attempted to fill this gap in the literature by developing an implementation model with multiple outcomes and groups of independent variables. The authors present four implementation outcomes (acceptance, use, performance, and overall satisfaction) as part of a causal chain that includes feedback loops. EVM is assumed to be successful to the extent that it is accepted, used by project managers, helps realize performance objectives, and provides overall satisfaction to users. Roughly 40 independent variables were grouped into four categories: EVM users, methodology, project environment, and implementation process.

By surveying EVM users and conducting multiple case studies, the authors found that several factors were critical to successful EVM implementation: sponsorship from senior management, experienced project managers and EVM users, tailoring of practices to fit project

context, training programs, and close communication with customers. This research was significant for providing an initial synthesis of EVM implementation. However, aside from this, the systematic study of implementation has been limited to GAO studies of federal agencies and a global cross-industry survey sponsored by PMI.

In response to the "truly remarkable growth of EVM as a best practice for performance management" (Song, 2010, p. ix), PMI sponsored a study to provide a better understanding of usage, policy and practice guidance, EVM's contribution to project outcomes, and conditions supportive to effective use. This global and cross-industry study found that EVM was practiced in 61 countries, from almost every region in the world, and that use had expanded from national defense projects to a wide range of sectors. Most private sector EVM users in the survey reported using PMI as their policy standard; the majority of "defense/government" users reported U.S. federal EVM policy as their standard. Regarding EVM's contribution to project outcomes, users agreed that EVM provides early warning of performance issues, improves communication, and assists project teams in meeting performance objectives (Song, 2010). On conditions supportive to effective implementation, the results were mostly consistent with the work conducted by Kim and colleagues (2003). That said, these studies sought to better understand EVM in a generic sense, and touched only briefly on distinctions between private and public use.

The systematic study of EVM implementation in the public sector has been limited to GAO studies of federal agencies, which focused on the nature of policy and how policy affects implementation. Because EVM is a set of interrelated project management practices, the nature of policy is critical in realizing the intended benefits (Christensen, 1998; Kim et al., 2003; Song, 2010; U.S. Government Accountability Office, 2009a, 2009b). By properly defining the core practices that comprise EVM at the enterprise level, policymakers can help ensure that major

projects are subject to appropriate oversight and management procedures. Adherence to project management best practices provides a necessary set of conditions for project data to be comprehensive, reliable, and usable for decision making purposes (Project Management Institute, 2011, 2017; U.S. Government Accountability Office, 2009a).

To improve EVM implementation, GAO has defined key elements of EVM policy (U.S. Government Accountability Office, 2009a), including establishing clear criteria for application, conducting independent reviews of performance baselines, training programs and requirements, defining clear criteria for revising cost and schedule baselines, and performing system surveillance. Following OMB's directive for federal agencies to use EVM on major IT projects, GAO conducted investigations of eight federal agencies to determine the extent to which EVM policy is consistent with best practices (U.S. Government Accountability Office, 2009a). GAO found that, although agencies had established policies requiring use of EVM for major IT projects, the policies were not fully consistent with best practices. Of note, most lacked training programs and sufficient criteria for baseline revision. Moreover, a close examination of several major projects found inconsistent application of EVM to be attributable to weaknesses in policy, as defined, coupled with a lack of enforcement. GAO concluded that until the agencies investigated defined policy more robustly and enforced their policies more consistently, it would be difficult for them to fully realize the benefits of the practice.

Single case studies conducted by GAO have mostly been consistent with these findings (U.S. Government Accountability Office, 2007, 2008, 2010, 2012, 2015, 2016, 2019). However, they have also pointed to factors critical to effective implementation other than the nature of policy, such as leadership, organizational culture, and human capital. For example, EVM application at NASA was met with resistance due to an institutional focus on transformative

science and engineering challenges, and not necessarily the project management challenges of these endeavors (U.S. Government Accountability Office, 2012). Consequently, most personnel at NASA lacked the willingness and ability to perform EVM. For this reason and others, GAO has kept a close eye on NASA in its High-Risk Series, noting that progress has been made, but that there is still considerable room for improvement in EVM application (U.S. Government Accountability Office, 2019).

Potential future changes to monitor at the federal level include scalable EVM and refinement of EVM policy to align with the dynamic nature of IT acquisitions. A tenet of enterprise project management states that practices should be tailored according to the size, complexity, and risk of a project (Project Management Institute, 2016, 2018). In this regard, it is possible that concepts such as "EVM lite," a simple and flexible version of EVM for smaller projects, will continue to be developed, and may eventually become codified into federal policy. The dynamic and iterative nature of IT projects has tested traditional project management strategies that emphasize control and predictability, with some calling for the development of more flexible approaches that can adapt to uncertainty (Sutherland, 2014; U.S. Department of Defense, 2018b). Therefore, the DoD has explored how "agile" project management philosophies can coexist and prosper with EVM (U.S. Department of Defense, 2018a).

In this research, it is understood that the term "agile" can be problematic because it lacks a common meaning. Here, it is treated as a normative conception of project management, consistent with Sutherland's (2014) definition. In this respect, agile is considered not an actual methodology, but a philosophy. However, some methodologies, such as Scrum, are considered agile styles of project management, which can, at a summary level, be contrasted with "traditional" styles that place a premium on control and predictability. In traditional project

management, emphasis is placed on clear specification of requirements in advance, detailed planning to meet requirements and mitigate associated risks, and hierarchy to promote accountability. In contrast, agile styles tend to embrace flexibility and uncertainty as part of the regular order. As a result, requirements are often discovered through user engagement during project execution, front-end planning is minimized to avoid wasted motion, and collaboration among project stakeholders is prioritized to promote customer satisfaction.

Performance Measurement

Practitioners have also played a critical role in developing measurements and empirically studying the predictive value of EVM. However, unlike reform and implementation, the area of performance measurement has received significant attention from academics in the last 15 years. As mentioned, following the high-profile cancellation of the A-12, DoD initiated a study of over 400 defense projects. Its analysis of cost-overruns led it to conclude that EVM indicators consistently identified them once projects were approximately 15% complete.[6] Moreover, for projects with overruns at 15-20% complete, performance was likely to deteriorate. Because of this, the Navy's inquiry officer was critical of the A-12 team using EVM indicators as a ceiling for the total cost estimate (Christensen & Heise, 1993). On a go-forward basis, any cost estimate for a DoD project that was lower than that generated using simple EVM indicators had to be justified by explaining how future cost performance would improve.[7] Shortly after the DoD report was issued, independent research was conducted to examine the predictive value of basic EVM indicators for cost-overruns (Christensen & Heise, 1993; Christensen & Payne, 1992). The findings were consistent with the assertions made in the DoD report. Specifically, cost-

[6] Using the IEAC as explained in Appendix A.

[7] Specifically, the IEAC is used to provide an estimate of the total cost. If tolerance thresholds are broke, discussions focus on why/how future performance will be better than past performance. In this regard, the IEAC is more of a communication tool than an estimate.

performance was found to stabilize at 20% complete, meaning that overruns could be identified using simple EVM metrics and provide opportunity for early intervention.

Prior to the emergence of more advanced cost and schedule forecasting studies, the focus shifted towards the development of new measures of schedule progress. Lipke introduced a concept derived from EVM that he dubbed “Earned Schedule” (ES). As he explained, ES helps to identify the point when the earned value accrued should have been earned (Lipke, 2003, 2004). In Appendix A, Figure A.1, the schedule variance using ES is on the horizontal axis (in units of time) whereas in old-school EVM it is only on the vertical axis (in units of money). Research on ES has found that it improved EVM application for time metrics, specifically by reporting schedule progress in more useful terms and developing better project duration forecasts (Lipke, 2012).

To further improve schedule reporting, Khamooshi and Golafshani (2014) developed “Earned Duration” (ED), also derived from EVM. ED goes beyond ES by completely decoupling cost and schedule metrics and expressing the variance strictly in terms of activity durations. That is, the planned durations of activities themselves are used to create a baseline against which earned and actual durations can be compared (Khamooshi & Golafshani, 2014). The important point is that the selection of measurements shapes communication among project stakeholders; ES and ED speak more directly to measures of schedule progress and their implications for corrective action. For example, ED can be used to state precisely how many engineers may need to be added to a project to meet schedule objectives. PMI has endorsed ES for reporting schedule progress; ED may begin to increase in popularity (Project Management Institute, 2017).

In the last two decades, as academics have entered the research domain, more advanced quantitative studies have emerged that use EVM indicators for prediction. Following the

development of the new time metrics derived from EVM, research compared different project duration forecasting methods (Batselier & Vanhoucke, 2015). At the summary level, both ES and ED can provide relatively simply project duration forecasts. However, because both rely heavily on past performance as a predictor for future performance, they should be used in combination with bottoms-up approaches, to account for potential corrective actions being taken by project managers. One example of an advanced blended technique uses a Bayesian approach to blend historical data with expert opinion (Caron, Ruggeri, & Merli, 2013). Other advanced quantitative areas of focus have used techniques from statistical process control to estimate likely variances, in order to establish tolerance thresholds and plan for risks arising from project uncertainty (Colin & Vanhoucke, 2014). Although these studies have shed light on the potential benefit of more advanced project management techniques, more practical concerns remain for the majority of public sector practitioners, such as establishing and implementing basic project management guidelines.

Who Uses EVM? What Do They Get Out of It? What Makes It Work?

EVM has evolved to be an internationally-recognized best practice in project management, with evidence of use in 61 countries and dozens of industries. It has evolved from a predominately compliance mechanism for national defense projects to a management tool used voluntarily by private contractors. Although evidence exists of use in national governments and private industry, there is no empirical analysis of EVM use in subnational governments, aside from a single case study of the Washington Department of Transportation. The body of evidence shows that EVM can be an effective early warning system for cost-overruns and schedule delays, improve communication, facilitate corrective action, and help project teams achieve cost and schedule objectives. However, more research is needed to examine if EVM provides these

contributions to project management in subnational governments and how different types of project environments complicate or simplify implementation. Several conditions are critical to effective implementation, such as sponsorship from senior management, experienced project managers, and EVM users, tailoring of practices to fit project context, training programs, and close communication with customers.

Earned Value and Public Management

The schematic in Figure 2.2 shows how subfields of EVM and public administration can be integrated to add to our knowledge of public management and policy. The EVM body of knowledge shares key points in common with major themes of public management and budgeting literature. On reform, the evolution of EVM is consistent with Schick's seminal analysis of budget reform in the U.S. federal government (Schick, 1966), since the central theme of early reforms was control and financial oversight (CS CSC). However, subsequent reform emphasized management, specifically the needs of project managers (EVM).

The federal EVM experience also supports the idea that successful and lasting budget reform requires consideration of the dynamic objectives and needs of organizations and practitioners (project managers, in this case), and the tools they need to pivot quickly to accommodate change (Forrester & Adams, 1997). EVM can be classified a hidden New Public Management reform (Osborne & Gaebler, 1992), with policymaking authority given to industry to emphasize "insight, not oversight" (U.S. Government Accountability Office, 1997). EVM reforms in the U.S. federal government aimed to establish high levels of accountability for the results of government spending, while giving discretion to industry to define effective management processes. This is consistent with Moynihan's performance management ideal type

(Moynihan, 2008, p. 33), which provides for high managerial discretion to foster high performance results.

Similar to the tone of the "first generation" of policy implementation literature (Pressman & Wildavsky, 1974), early research provided a synopsis of the failures of CSC. However, unlike policy implementation literature, subsequent generations of EVM research did not evolve to develop a variety of competing theoretical frameworks. Notably, the EVM body of knowledge has not utilized foundational policy implementation literature to develop theory. As the policy implementation literature explains, policymakers have a unique set of tools at their disposal to structure the implementation process (Mazmanian & Sabatier, 1989; O'Toole, 2000). The EVM body of knowledge points to multiple "levers" that can promote effective use, such as enabling legislation that explicitly defines industry standards for policy development, requiring professional certifications for project managers, establishing training programs and requirements, conducting independent reviews of performance baselines, developing corrective action plans based on EVM indicators, and performing system surveillance to ensure that policy is consistently applied. This logic aligns with top-down models of policy implementation, which tend to view policymakers as the central actors, use policy decisions as the starting point, and concentrate attention on factors that can be manipulated at this level (Mazmanian & Sabatier, 1989).

EVM is another illustration of the importance of performance information for budget execution, enabling continuous analysis of metrics to inform budget management (Ho, 2018; Joyce, 2011; Lauth, 1987; Melkers & Willoughby, 2001; Moynihan, 2008). As explained, GAO has conducted several studies that demonstrate the need for comprehensive policy for the effective use of EVM data. These findings are consistent with research on performance

budgeting law in the states (Lu, Willoughby, & Arnett, 2011): specifically, thorough instructions on the development, reporting, and use of performance data support stronger use of performance budgeting systems in state governments. However, what is unique to EVM is its functionality as a real-time multidimensional performance management tool for capital projects.

Research in public management has identified project management as an essential component of a comprehensive capital budgeting process, to ensure that projects are delivered on time and within budget (Ammar, Duncombe, & Wright, 2001; Ebdon, 2004; Jimenez & Pagano, 2012; Srithongrung, Yusuf, & Kriz, 2019). However, aside from suggesting possible advantages of establishing centralized offices to oversee project execution, the field has not conducted substantive research on capital project management strategies and the results of implementing them in different project environments. All things considered, a fair criticism of research in public management is that its neglect of project management has prevented a coherent understanding of capital budgeting. Therefore, research on enterprise project management and EVM fill a consequential knowledge gap, especially given the historical record of cost-overruns for major capital projects and the ambitious and costly challenges that lie ahead for governments around the world. However, to be fair to public management, the field of project management has criticized itself for a lack of empirical research on project governance (Project Management Institute, 2016, p. 106-107). Thus, studying EPMOs in the states and implementation of EVM offer a rich policy and practice laboratory for both project and public management.

Conclusion

In summary, the practice of EVM in the U.S. federal government emerged in the 1960s as an acquisition management reform, quickly diffusing to other U.S. federal agencies, and eventually to other national governments. Although EVM has been studied for decades,

relatively few attempts have been made to develop theory and synthesize findings. This chapter provides an historical account of the origin and evolution of EVM in the U.S. federal government, a comprehensive review of the EVM body of knowledge, and a roadmap to integrating EVM into the mainstream of public management literature. To advance our knowledge of project governance and EVM in the public sector, Chapter 3 provides the first empirical analysis of enterprise project and earned value management in U.S. state governments.

Project Monitoring Strategies

Strategy	Advantage	Disadvantage
Spend Plan	Charges all costs to project, compare planned cost to actual cost	Comparison of planned cost to actual cost only meaningful if project is on schedule throughout execution (rare)
Schedule of Values/ Percent Complete	Simplicity; Compare percent complete to percent spent as major components are delivered	Stale data; Need framework for decomposing project further into milestones and measuring progress more frequently
Earned Value Management	Integrated solution for establishing project milestones, measuring progress, and analyzing results on at least a monthly basis	Complexity; Requires project management discipline, maturity, and integrated reporting tools.

FIGURE 2.1: Project Monitoring Strategies

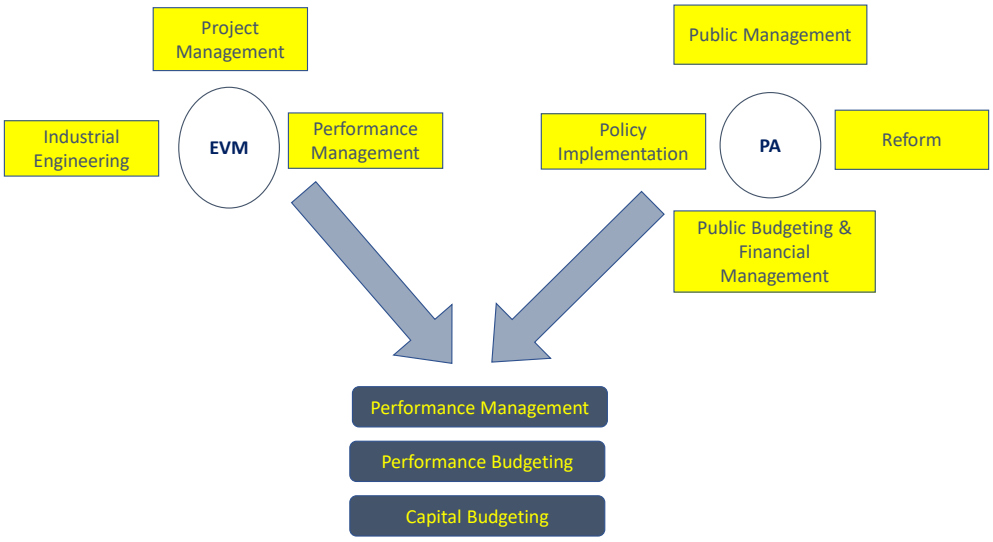


Figure 2.2: Integrating Earned Value and Public Administration

CHAPTER 3

A STRATEGIC FRAMEWORK FOR ENTERPRISE PROJECT AND EARNED VALUE MANAGEMENT

Enterprise Project Management (EPM) is an organization-wide strategy for project governance and management. The concept of EPM extends beyond the traditional focus on procedural details of planning and execution. An EPM strategy consists of multiple core components, such as strategic alignment, human capital development, and project management methodology (Project Management Institute, 2016). Because every state agency requires Information Technology (IT) to achieve their mission, state governments are in the permanent business of IT project management. Thus, development of robust EPM strategies in state government is critical to avoid the notorious "ticking time bombs" of IT project management (Flyvbjerg, 2017), namely, project failures and devastating cost-overruns (Bloch, Blumberg, & Laartz, 2012; Standish Group, 2015).

This chapter provides original research on EPM strategies in state government. Specifically, it answers the first primary research question of this dissertation: have states adopted EVM as a component of their EPM strategy for IT projects? The author developed a strategic framework for enterprise level EVM policy in order to conduct a comparative analysis of the states. To unearth primary data on the operations, policies, and experiences of the states, a mixed-methods approach involving document reviews, surveys, and interviews was utilized. Policy scores for states were calculated using this strategic framework and primary data.

An analysis of 31 states found that most had taken pivotal steps in developing an EPM strategy, such as establishing Enterprise Project Management Offices (EPMOs) and developing policy based on industry standards. However, in 17 of 31 states, agencies are not required to follow EPMO guidelines. EVM its currently used in 18 states; thirteen have no plans for EVM adoption or usage in the future. In comparison to the federal government, EVM in the states is relatively new, flexible, and decentralized.

This chapter begins by presenting a strategic framework for enterprise level EVM policy in state government. It then describes the methods used to validate the framework, collect primary data, and conduct a comparative analysis of the states. The next section provides results that depict the "state of the states" in regard to enterprise level EVM. Finally, the chapter concludes by integrating findings with the EVM body of knowledge, as well as that of public management and policy.

Strategic Framework

As the policy implementation literature explains, policymakers have a unique set of tools at their disposal to structure the implementation process (Mazmanian & Sabatier, 1989; O'Toole, 2000). In particular, top-down approaches view policymakers as central actors, take policy decisions as their starting point, and concentrate attention on factors that can be manipulated at this level. Mazmanian and Sabatier's (1989) model, which identifies several conditions for the effective implementation of legal objectives, is useful for illustrating the basic features of a top-down model of policy implementation. The authors identify three conditions that can be dealt with by initial policy decisions: clear and consistent objectives, the assignment of implementation to sympathetic agencies with adequate hierarchical integration, and adequate causal theory. Relating this to IT project management in state government, policymakers can

establish EPMOs and provide them with authority to establish new policies and procedures that agencies must then abide by.

Along these lines, this section provides a top-down strategic framework for enterprise level EVM in state governments. Each element of the framework is depicted in Figure 3.1.

Enterprise Project Management Office

In state government, EPMOs can be assigned responsibility for several vital budgeting functions concerning strategic alignment and project management methodology. For the purposes of strategic alignment, EPMOs may coordinate budget preparation and approval for major IT projects. Concentrating responsibility for these duties in the EPMO can help provide a holistic view of technology needs to inform decision making, which a decentralized structure may struggle to offer. For example, EPMOs can issue instructions to executive agencies for developing their business cases, review budget requests, make recommendations to the governor's office, and advise the legislature on dollar amounts. On project management methodology, EPMOs can issue policy standards and practice guidance to executive agencies for major IT projects, monitor their performance during execution, and take corrective actions to remedy performance issues. This ensures that industry standards are consistently applied across state agencies during budget execution, so that stakeholders understand project status and potential risks.

The EPMO can affect human capital by building the capacity of state agencies, by providing training, consulting services, and avenues to professionalization. By establishing training programs for project managers in core areas, such as requirements, scheduling, cost-estimation, etc., the EPMO ensures that the competencies and skills needed are ready for deployment across state agencies. Consulting services can be targeted for advanced or niche

expertise on an as-needed basis. In some cases, the potential bargaining power of the EPMO may be able to secure such services at lower rates than agencies would on their own.

Numerous studies point to the need for training to realize the intended benefits of EVM (Kim, Wells Jr, & Duffey, 2003; Song, 2010; U.S. Government Accountability Office, 2008, 2009a, 2012, 2016, 2019). In the U.S. federal government, GAO has found that enforcement of training requirements is critical to ensure that agencies have the appropriate skills for EVM. For this reason, GAO emphasizes the need for EVM training requirements for federal personnel with investment oversight responsibilities, including senior executives (U.S. Government Accountability Office, 2009a, 2019). State governments can consider integrating EVM into their training and consulting services as well, but some state agencies may first need to establish more basic project management competencies, such as scheduling.

Finally, an EPMO can also play a key role in leading and managing organizational change as new processes are established and spread into state agencies. In large organizations, where changes are implemented across several divisions, the Project Management Institute (PMI) has recommended establishing organizational change teams with representatives from the divisions responsible for implementing new processes (Project Management Institute, 2018). This is intended to increase acceptance of change and provide a better understanding of the unique needs of each division. In state government, these teams could help facilitate change across a vast number of state agencies.

Policy Standards and Guidelines

A policy standard serves as an authoritative source for the development of project management guidelines. Generally speaking, industry standards offer several advantages to building guidelines from scratch (Project Management Institute, 2018). Industry standards are

developed by subject matter experts and updated regularly, and are comprehensive and internationally-recognized. For example, an EPMO may establish the *Project Management Body of Knowledge (PMBOK)*, issued by the PMI, as a policy standard. However, the PMBOK itself is a voluminous set of manuals. To clarify expectations and establish accountability, the EPMO can focus their attention on defining guidelines for a reasonable number of critical practices. Once the guidelines are established, it should be made clear that agencies must follow them in managing their major projects, with exceptions granted by the EPMO.

EVM is a set of interrelated practices, so properly defining guidelines is critical for ensuring that project data is comprehensive, reliable, and used for decision making purposes (Project Management Institute, 2011; U.S. Government Accountability Office, 2009b). For example, the U.S. federal government defines specific guidelines for planning, scheduling, budgeting, accounting, data analysis, and baseline revision. However, as explained in Chapter 2, these guidelines were designed to serve control and management functions for major federal acquisitions. To promote a leaner and less restrictive approach to EVM for the global project management community, the PMI issued EVM guidelines in 2005 (Song, 2010). A global, cross-industry survey of EVM users found the PMI standard to be dominant in the private sector, while the U.S. federal standard was most typical for "defense/government" (Song, 2010).

In most U.S. federal agencies, EVM policy calls for an Integrated Baseline Review (IBR) to be conducted within six months of a major contract award (National Defense Industrial Association, 2016; U.S. Government Accountability Office, 2009a). The purpose of conducting an IBR is to establish a mutual understanding among project stakeholders of the risks involved in delivering the project and the management processes to be used during execution (National Defense Industrial Association, 2015). Typically, an independent party, such as an external

consulting firm, will conduct the IBR. The advantage of conducting an IBR is that it may identify specific risks related to the technical scope, schedules, cost-estimates, and performance management tools that otherwise would be discovered later (National Defense Industrial Association, 2016; U.S. Government Accountability Office, 2009a). An IBR is not necessarily a one-time event; it may be conducted as a project moves through major phases.

The last decade has brought discussion of expanding the use of pre-award IBRs in the U.S. federal government (National Defense Industrial Association, 2010). The cost-overruns and schedule delays experienced by major programs have resulted in pressure to direct contract awards to programs that demonstrate an adequate likelihood of achieving their technical, schedule, and cost objectives. However, the extent to which IBRs are consistently conducted at all is unclear, let alone pre-award IBRs.[8] Therefore, in state government, EPMOs should establish clear guidelines for conducting independent reviews of performance baselines. At the project level, this may contribute to a greater understanding of risks and an opportunity to adjust early to mitigate. At the enterprise, or portfolio level, it can potentially offer valuable information when selecting among competing alternatives.

Criteria for Application of EVM

To ensure consistent application of EVM on major projects, clear criteria on the timing of implementation should be provided in the project management guidelines. In 2005, the Office of Management Budget (OMB) directed all federal agencies to implement EVM on all "major IT investments" (U.S. Government Accountability Office, 2009a). However, each agency was given broad discretion in defining "major," and in deciding when to use EVM, based on specific facts and circumstances (Song, 2010; U.S. Government Accountability Office, 2009a). Agencies have

[8] Meeting with EVM experts at Government Accountability Office.

elected to consider a variety of factors when determining to use EVM, such as contract value, contract type, project duration, and risk (National Defense Industrial Association, 2016; Song, 2010). Most often, federal agencies require EVM for projects exceeding $20 million that involve development, modernization, and/or enhancement. Thus, although agencies were given broad discretion in defining "major," they have used specific terms to define it internally to ensure consistent application (National Defense Industrial Association, 2016; U.S. Government Accountability Office, 2009a).

The perspective taken in this top-down model is that the EPMO should not provide broad discretion to state agencies in determining when to use EVM. Instead, the EPMO should require use of it under specific circumstances. Specifically, the use of vague terminology, such as "major," should be avoided and replaced with more objective phrasing, such as that specifying contract value, contract type, and project duration. By incorporating explicit language into the guidelines, agencies can be held accountable for their schedule and cost objectives throughout execution. Specific guidance supports clarity of process and can also help agencies better manage costly and risky projects responsibly.

Tailoring

Adopting industry standards is a critical step in developing guidelines. However, such standards, generic by nature, are not necessarily intended to be applied uniformly across an organization. A central EPM design principle is to tailor practices according to project cost, risk, and complexity (Project Management Institute, 2016, 2018), by developing criteria to classify projects into groups, and explaining how practices should vary based on these classifications. The idea behind tailoring is simple—one size does not fit all. If procedures are not intensive

enough, risk is introduced. However, if procedures are too intensive, inefficiencies result. Tailoring can also involve supplementing industry standards with sector specific guidance.

In the case of EVM, this could involve the development of a scalable process, in which it is applied more intensively to "high-risk" than to "low-risk" projects. (National Defense Industrial Association, 2018). For example, "high-risk" projects may be subject to detailed independent reviews of performance baselines and monthly reporting, while "low-risk" projects may not require detailed independent reviews and can be reported on a quarterly basis. For sector-specific guidance, steps can be taken to explain how EVM can be implemented consistently with agile principles (Ghosh, 2015; Rusk, 2009; Sulaiman, Barton, & Blackburn, 2006; Torrecilla-Salinas, Sedeño, Escalona, & Mejías, 2015), to better educate IT project managers on the benefits and implementation of EVM in their specific operating environments.[9]

One typical example given to illustrate how to recognize progress involves points assigned to user stories. As user stories are completed, a project manager learns their team's velocity. As Sutherland (2014), the inventor of Scrum, explains:

> We have all these stories—these things that need to be done. And we've estimated them––this one is an eight, this one is a three, and so on. And then we start on our first Sprint. Let's say it's a week long. At the end of the week we count up all the stories we've completed, total the points they were estimated at, and that number tells how fast the team is going, their velocity. And once you have a velocity, you can look at how many stories you have left and how many points they represent, and then you know when you'll be done. [10]

[9] For example, some managers may falsely assume that EVM is a waterfall strategy. In reality, real agile strategies, such as Scrum, give EVM exactly what it needs---timely measures of progress.
[10] (Sutherland, 2014), p. 139.

In this approach, EVM application can be done with resource estimates for stories. However, it must be emphasized that in this style of EVM implementation, it should be the duty of budget analysts, not engineers, to convert this data to units of money and speak to those results.

Methods and Data

As Figure 3.2 shows, the research methods and data for this chapter involve the use of document review, a focus group, and implementation of electronic surveys and telephone interviews. The first stage of the document review, which occurred throughout the study, was a preliminary sweep of state EPMOs, examining authorizing legislation, mission statements, strategic plans, performance reports, and project management guidelines. Following this first document review and completion of a comprehensive literature review, an initial strategic framework was developed. To assess the content validity of the framework, the author conducted a day-long focus group with leading EVM experts at GAO headquarters in Washington, D.C. These experts agreed that the elements of the framework constitute a comprehensive strategy, and provided feedback on refining properties of certain elements.

Following consideration by GAO, subsequent document review engaged analysis of project management guidelines to determine consistency with industry best practices, as specified in the framework. The analysis found that the vast majority of states define their guidelines for planning, scheduling, cost-estimation, and baseline review consistent with PMI. However, EVM policy is not typically specified in project management guidelines. Therefore, the framework was delimited regarding details of project management guidelines, focusing instead on the more central issue of whether agencies must follow EPMO guidelines in managing their projects and the application of EVM.

An electronic survey was designed to collect primary data from state governments on their project management offices, project management guidelines, and the application of EVM. Previous EVM survey research was used as a guide in developing question stems and answer choices on the questionnaire, specifically Song's (2010) global and cross-industry survey of EVM users, sponsored by the PMI and extensively piloted in the project management community. Document review also informed survey development: guidelines for planning, scheduling, cost-estimation, and baseline review were mostly defined consistent with industry standards. However, EVM policy was typically not defined. Therefore, for the sake of brevity, the author minimized details on guidelines and emphasized specific components of EVM policy. Document review further informed the development of the survey by determining response options for questions related to the number of years offices have been in existence. As the results section shows, the response options provided a sound basis to represent the chronology of project management in the states. The survey instrument is provided in Appendix B.

The tailored design method was used for the survey (Dillman, Smyth, & Christian, 2014). Like any surveying strategy, the tailored design aims to reduce sources of error relating to coverage, sampling, nonresponse, and measurement. Uniquely, though, the tailored design method emphasizes the importance of social exchange for establishing trust with respondents and incentivizing response. As Dillman and colleagues (2014) explain, in the new digital landscape of surveys, researchers can take steps to establish trust in asking for participation. The author heeded these guidelines, sending letters through physical mail, using official University of Georgia envelopes and letterhead, notifying subjects that they would be sent an electronic invitation to participate in the survey on a specific date. To incentivize response, participants

were offered a copy of research findings and invited to attend a collaborative webinar to discuss study results and share lessons learned with other experts.

Each of the 50 states were contacted to participate in the study. In the majority of states, letters were addressed to the director of the EPMO. In states where an EPMO could not be verified, letters were addressed to chief information officers, requesting a point of contact for the survey. A total of 31 states responded to the survey (see Figure 3.3), providing a rich set of implementation environments that vary on demographic, economic, geographic, and political dimensions. Categorizing the states into five quintiles of ten based on population revealed that each quintile contained at least five of the responding states. As Figure 3.3 shows, participating states are also spread across various geographical regions of the country and represent a good mix of conservative and liberal political environments.

To conduct a comparative analysis of the states using the survey data, an index was created using the elements of the framework, conceptualized as sequential and interrelated steps in structuring the project management lifecycle. The index is composed of seven nominal variables, including the existence of: EPMO, policy standard, guidelines, centralization, EVM, criteria for application, and tailoring. As Table 3.1 shows, a variable is coded as 1 if the criterion exists and 0 if it does not, and scores for states can range from 0-7. Therefore, states that have adopted more comprehensive EPM and EVM reforms score higher on the index. A state that has not adopted EVM can score no higher than 4. To reiterate, since the document review found that guidelines for traditional project management practices, such as planning, scheduling, cost-estimation, and performance baseline review, were consistent with industry standards, the index was reduced to these major policy components. The index is intended to provide a simple descriptive “state of the states” regarding framework components.

Explanatory analysis of the survey and interview results and document review yielded information on the impetus for reforms. Interviews were included in the design to provide additional context to the survey results, specifically for insight into the origin and evolution of state EPMOs, policy adoption and diffusion, and the implementation of EVM in the state government. A total of 11 semi-structured interviews were conducted as a follow-up to the survey received from that particular state; interviews, all held with the same person who completed the survey, lasted from 30 to 60 minutes. A thorough document review was performed for each state prior to the interview.

Results

Figure 3.4 provides summary results for the 31 states. Findings indicate that the vast majority of states have taken key initial steps, such as establishing EPMOs and developing policy based on industry standards. However, agencies are only required to adhere to EPMO guidelines in 14 of 31 states. EVM is used in 18 states, with most defining criteria for application and tailoring practices according to project context. Table 3.2 provides a detailed breakdown of the scores for each state, showing an average score of 4.5 (standard deviation of 1.7). A map chart provides snapshot of the results by state. As noted in the Figure 3.5 legend, states with higher scores are presented in deeper shades of blue. The following section elaborates on findings for each element of the framework.

As Figure 3.6 shows, 27 of 31 states have established EPMOs during the last two decades.[11] Document review and interviews point to major issues relating to performance and accountability, likely impetuses for this establishment. IT projects gained notoriety for

[11] To be clear, not all EPMOs perform the same operations and have the same reach. What each of these offices do have in common is that they are responsible for enterprise projects, such as Financial Management Information Systems.

consistently failing to meet technical, schedule, and cost objectives in ten of the 11 states in which an interview was conducted. In some cases, large-scale project failures served as focusing events. These performance issues often led to investigations revealing the need for basic reforms, such as adopting industry standards, defining project management guidelines, establishing measures of progress, and holding agencies accountable for results. EPMOs were formed in recognition of the need to improve IT project delivery, implement new procedures, and increase accountability across state agencies.

For example, document review, survey responses, and a follow-up interview yielded a rich account of the origin and evolution of the New Mexico EPMO. Notably, this state is very transparent with the public regarding the impetus for the establishment of their EPMO, describing their legacy governance system as disconnected (State of New Mexico Department of Information Technology, 2015). Specifically, a scathing audit from the Legislative Finance Committee attributed performance issues to a lack of industry standard practices, stale metrics, and weak central oversight. As a result, a series of reforms began in 2007. Over time, the office has evolved from a control orientation, describing more recent changes as collaborative and non-threatening (State of New Mexico Department of Information Technology, 2015).

In Virginia, the EPMO was established for the same reasons: performance issues led to an audit conducted by the Joint Legislative Audit and Review Commission (Commonwealth of Virginia, 2003). The audit found lack of adequate project management to be a major contributing factor to project failures. In response, the EPMO was established to improve project delivery by establishing industry standard practices, conducting centralized oversight, and building the project management capacity of state agencies. Overall, results have been positive. An officer stressed the importance of establishing guidelines that agencies are capable of executing based

on their maturity, providing the necessary training and education to implement new procedures, and incorporating change management to handle the transition to heightened levels of accountability. Each interview revealed the importance of such change management strategies.

Project management reforms in the states have not been limited to project delivery: they also involve strategic alignment and human capital. Concerning strategic alignment, many states have assigned their EPMO responsibility for ensuring that projects are prioritized to optimize return on investment, by coordinating budget preparation and approval for major IT projects. Several of the EPMOs interviewed work with agencies to develop their business cases, review agency budget requests, make recommendations to the governor's office, and advise the legislature on funding levels. For example, in Alabama, most state agencies did not include any formal investment analysis in their budget requests, leaving a growing number of costly projects noncomparable, confusing, and unwieldy. Therefore, in 2013, responsibility for budget preparation was concentrated in the EPMO. The results have been positive, with key stakeholders more confident in their financial decisions with the EPMO performing central clearance. An officer from Washington explained their role in budget preparation and approval:

> Funding requests are prioritized based on pre-established criteria as input to decision makers. The CIO's office also makes specific funding recommendations, including recommendations to not fund certain requests if certain conditions are missing. This allows better allocation of limited funds.

In addition, EPMO involvement in agency planning can help ensure that all technology components of a project have been accounted for in legislation. An officer from New York provided a specific example:

> Legislation for the monitoring of water across NYS [New York State] schools requires implementation of sensors, data warehouse, and data analytics. But these costs were not factored into the legislation. So the IT aspect is unfunded but crucial to success. By tying the IT budget to the legislation, it guarantees funding across fiscal years and makes budgetary decisions more constant across the life cycle of the project.

In regard to human capital, EPMOs have aimed to professionalize project management in state government through training, education, and consulting services. In Virginia, for example, initial reforms created the "Project Manager Selection and Training Standard," establishing minimum qualifications and training standards for all project managers (Commonwealth of Virginia, 2003). The "Project Manager Development Program" was then formed to ensure that agencies gained the desired qualifications and leadership skills. As Figure 3.7 shows, many EPMOs provide a wide range of consulting services to state agencies, providing specific expertise on an as-needed basis.

Figure 3.8 presents sources used to develop policy and practice guidance. All of the states have used an industry standard to develop policy, specifically the PMI. Figure 3.8 also indicates policy diffusion has among the states, with roughly half citing other state governments. During the interviews, executives typically recalled two to three other states they looked to for guidance; Virginia, Michigan, and California were cited multiple times. In fact, an officer from Virginia confirmed that multiple states contacted them for general guidance in tailoring PMI for use on state IT projects. State EPMOs model less from the federal government. Only ten states indicated using federal guidance for traditional project management functions, and only two states use federal EVM guidelines. Finally, several states indicate using IT sector sources in tailoring the generic PMI practices when defining their own guidelines.

As Figure 3.4 shows, 27 of the 31 states have defined project management guidelines. Thus, while all 31 states cite PMI as a policy standard, four states have yet to define their guidelines. The document review indicates that the vast majority of guidelines are comprehensive for traditional project management activities, such as planning, scheduling, cost-estimation, and performance baseline review. Figure 3.9 shows that the application of defined guidelines is almost evenly split between centralization and decentralization: agencies are required to use EPMO guidelines in 14 of 27 states, and in the other 13, the guidelines are recommended, but not required. In discussing guidelines with those in EPMOs, interviews focused on agency application of EPMO guidelines, performance baseline reviews, and EVM.

Regarding agency application of guidelines, five interviews were conducted with centralized states and six with decentralized ones. In the centralized states, most respondents indicated that requiring agencies to follow guidelines can lead to more consistent application and improved performance. In the decentralized states, four of six administrators agreed that providing agencies broad discretion to define their own guidelines contributed to inconsistent application, communication problems, and potential performance issues. For example, both Georgia (centralized) and New Mexico (decentralized) recommend use of EVM. In Georgia, the centralized application of guidelines facilitates orderly portfolio management. As an officer from Georgia explained, EVM indicators drive questions that are sent to teams in advance of meetings: the expectation is that they come prepared with answers. In contrast, in New Mexico, both agencies and individual project managers are given discretion in determining when to use EVM. In this officer's experience, communicating with EVM users is simple because they demonstrate an understanding of their true project status. Non-EVM users exhibit a lack of

discipline, preventing the EPMO from analyzing their portfolio with a common set of indicators, which reduces the quality of information they are able to provide to stakeholders.

In each of the 11 interviews, administrators were asked about conducting independent reviews of performance baselines. Notably, each state has a clear process for determining which projects are subject to intensive review and the scope of review. Each respondent communicated that reviews were regularly conducted and considered very effective. In many cases, these have contributed to more realistic performance objectives and early identification and mitigation of risk. In some states, the independent reviews occur throughout the project. For example, in New Mexico, the EPMO assesses “agency readiness” at major gates of the project. Agencies only receive funding for the next gate if the EPMO authorizes the release of funds. Notably, such conduct has been found to be uneven in the federal government (U.S. Government Accountability Office, 2009a). Thus, states may be on par with the federal government in the area of baseline review. An officer from Washington explained how they perform a function similar to that of New Mexico:

> Implemented gated funding on many major IT projects accounts for both funding provided in state budgets and 'in-kind' agency costs (from operating budgets). The process ties funding gates to specific deliverables. Advancement through gates is tied to demonstrated progress.

Figure 3.10 shows that 18 states currently use EVM; thirteen do not have plans for EVM adoption or usage in the near future. Figure 3.11 illustrates that EVM, first adopted by Georgia in 2004, is new to state government. Of the 18 current users, 15 began using EVM within the last decade. Regarding impetus for adoption, several EPMOs cited use of EVM by other states whereas only a few referenced the federal government (Figure 3.12). The most typical response

given was the general adoption of PMI best practices. In this regard, EVM adoption in U.S. state governments owes more to the PMI and copycat among the states than it does to the 50-year history of EVM in the U.S. federal government. Surprisingly, the survey and interviews revealed that, in many instances, EPMOs indicated ignorance of federal EVM guidelines. In other cases, the federal guidelines are considered unnecessary: PMI works fine, and is more appropriate given state agency maturity. This helps explain why states have adopted a different brand of EVM than that practiced in the U.S. federal and other national governments.

Figure 3.13 provides a breakdown of reasons given by non-EVM users. In five states, respondents indicated that they do not provide a directive to agencies because the office has not issued guidelines or those issued are minimal. Four states cited contractor inexperience, and responses in the other category point to employee inexperience as well. Other reasons given by nonadopters are more substantive. For example, some officers perceived EVM to be unsuitable for IT projects and/or not cost-effective to implement.

In one interview with a state that does not use EVM, an officer explained they did not recommend EVM because they felt it was incompatible with agile, assuming EVM was a waterfall technique. When the author explained how other states used EVM, the officer seemed more open to it, especially for Scrum.[12] Notably, a few officers mentioned that project managers occasionally use agile as a cover, to avoid certain protocols. As an officer from Kentucky explained, agile itself is simply a philosophy: real project management strategies that subscribe to that philosophy actually have structure and order. When asked if agile was ever used as a cover to avoid EVM, one officer responded, “Oh yeah, we call (expletive) on that all the time.”

[12] Also, the author explained their experiences using EVM with Scrum to the informant.

Of the 18 states that use EVM, 11 have defined criteria for its application (see Figure 3.4). Most often, criteria are defined using cost, duration, and risk. On the issue of cost, dollar thresholds vary significantly. While all enterprise projects in Kansas above $250,000 are required to use EVM, in Kentucky, where EVM policy is currently being drafted, it will be limited to projects greater than $5 million. On risk, administrators explained in interviews that project classification systems have been developed to tailor practices according to project context, with EVM recommended for projects with medium-to-high technical, schedule, and cost risks. The current EVM strategy in 11 of 18 states involves tailoring practices to project context. These respondents typically described tailoring as adjusting the intensity of performance baseline reviews, frequency of status reports, variance thresholds, and level of detail for variance analysis. Importantly, each officer explained that they also provided guidance on establishing measures of progress for IT projects, such as that discussed in the strategic framework.

Figure 3.14 provides a strategy matrix for the 18 states that currently use EVM. The matrix groups states into quadrants based on criteria for application and tailoring of practices. States that require agencies to follow EPMO guidelines are bolded. For example, in the upper left quadrant, nine states explicitly define criteria for EVM application and tailor practices according to project context. Of these, the ones in bold require agencies to follow EPMO guidelines. As shown in Table 3.2, the bolded states in the upper left quadrant score the highest on the index, as they satisfy all nominal criteria for the elements of the strategic framework.

Discussion

As Berry and Berry explain, there are two general primary explanations for the adoption of a new government program or policy: internal determinants and diffusion (Berry & Berry, 1990, 2018). Internal determinants focus on how characteristics of a jurisdiction and its operating

environment can lead to adoption. Diffusion is fundamentally an intergovernmental concept, viewing policymaking as a copycat game. These results point to the internal determinants of technological, political, and managerial factors contributing to the establishment of EPMOs and the adoption of industry standards. On policy diffusion, states mostly mimicked each other and generic industry standards, importing relatively little from the federal government.

As state governments entered the 21st century, government modernization led to a proliferation of large-scale IT acquisitions, as legacy systems were replaced and new ones were added. As state agencies confronted these "new kids on the megaproject block," they suffered a similar fate to the U.S. federal government and large corporations (Bloch et al., 2012; Flyvbjerg, 2017; Standish Group, 2015; U.S. Government Accountability Office, 2009a). That is, their major IT projects were consistently late and over budget. In some cases, large-scale project failures involving costly sunk investments served as focusing events for legislative attention. As a result, reforms were enacted to improve project delivery and hold agencies accountable for results. These hidden reforms can be distinguished from other, better-documented performance budgeting reforms in the states that tended to focus on agency- or program-level performance, operating budgets, and annual measures of progress (Lu, Willoughby, & Arnett, 2011; Moynihan, 2008). In contrast, these reforms featured capital projects as the unit of analysis and involved the development of real-time performance metrics.

However, in many states, reforms were not limited to project delivery; they also dealt with centralizing responsibility for budget preparation in the EPMO, to provide governors and state legislatures an enterprise view of technology needs, business case analysis, and investment recommendations. In this regard, the findings align with foundational budget reform literature. As Abney and Lauth explained, executive management is accepted because it facilitates

legislative control (Abney & Lauth, 1989). Several interviews revealed that budget preparation was very decentralized prior to the reforms. To paraphrase one officer, the state legislature considered the process out of control because agencies developed their own procedures for business case analysis and investment justification. This left a growing number of requests for costly projects non-comparable, confusing, and unwieldy.

Policy diffusion in this study can be divided in two categories, intergovernmental and industry. To reiterate, intergovernmental diffusion typically took the form of EPMOs mimicking each other and not the federal government. On industry factors, the PMI emerged as the dominant policy standard, with each state citing it as a source of practice guidance. The relative influence of state and industry policy in comparison to federal is especially pronounced in the case of EVM. Specifically, only two states have used federal guidelines to develop their EVM policy. These results are notable because previous research identified U.S. federal guidelines as the dominant policy standard used internationally for public sector EVM (Song, 2010).

Therefore, project management reforms in the states have points in common with the federal government, regarding the impetuses for establishment of EPMOs and adoption of industry standards, namely internal determinants. These include the abundance of large-scale IT projects, consistent schedule delays and cost-overruns, high-profile project failures, heightened attention to the results of government spending, and political environments supportive of performance management reforms (Moynihan, 2008). As the previous chapter explained, on the heels of the reinventing government movement Congress passed the Federal Acquisitions Streamlining Act of 1994 and the Clinger-Cohen Act in 1996. The latter specifically aimed to improve project delivery and increase accountability for federal IT acquisitions by giving OMB authority to establish performance objectives and measures of progress for federal agencies. As

the results of this study show, state governments adopted a similar posture: they centralized IT project management by establishing EPMOs and adopting industry standards.

However, there are notable points of variation with regard to EVM policy and application. In comparison to the federal government, state-level EVM is still in the early stages and relatively decentralized. Moreover, states have adopted a lighter version of EVM, requiring less intensive procedures to align with project context and agency maturity. To reiterate an important point made in the strategic framework, there is a key difference between EVM guidelines issued by the federal government and PMI. In the federal government, EVM defines the entire project management system: it is itself a comprehensive project control and management system. By contrast, PMI guidelines were issued as a leaner and less restrictive alternative to federal guidelines. PMI guidelines explain how to fit EVM into a generic project management system, instead of redefining it.

Conclusion

This chapter provides several discoveries to project management and public management and policy. For project management, it offers original research on EPM strategies in U.S. state governments. This study of 31 states found that the vast majority have taken key initial steps in formulating an EPM strategy, such as establishing EPMOs and developing policy based on industry standards. However, agencies are not required to follow EPMO guidelines in most states. Eighteen states currently use EVM and 13 have no plans for adoption or usage in the near future. In comparison to the federal government, EVM in the states is relatively new, flexible, and decentralized.

This study contributes to performance management and budgeting within public management and policy. On performance management, this research revealed a hidden and

important set of reforms in state government aimed at improving IT project delivery and increasing accountability for results via centralized oversight, adoption of industry standard best practices, establishment of schedule and cost objectives, and use of real-time performance metrics. Concerning budgeting, previous research has identified project management as an essential component of the capital budgeting process to ensure that projects are delivered "on time and on budget." However, aside from noting potential advantages of centralized oversight, the field has been relatively silent on project governance and management strategies. Therefore, this empirical analysis of EPMO strategies provides a significant upgrade to our understanding of centralized project oversight.

Having examined the adoption of EPM and EVM strategies in state government, the next chapter focuses on implementation. Specifically, it answers the other two primary research questions of this dissertation: what are the contributions to project management from EVM? What conditions are supportive to effective EVM implementation?

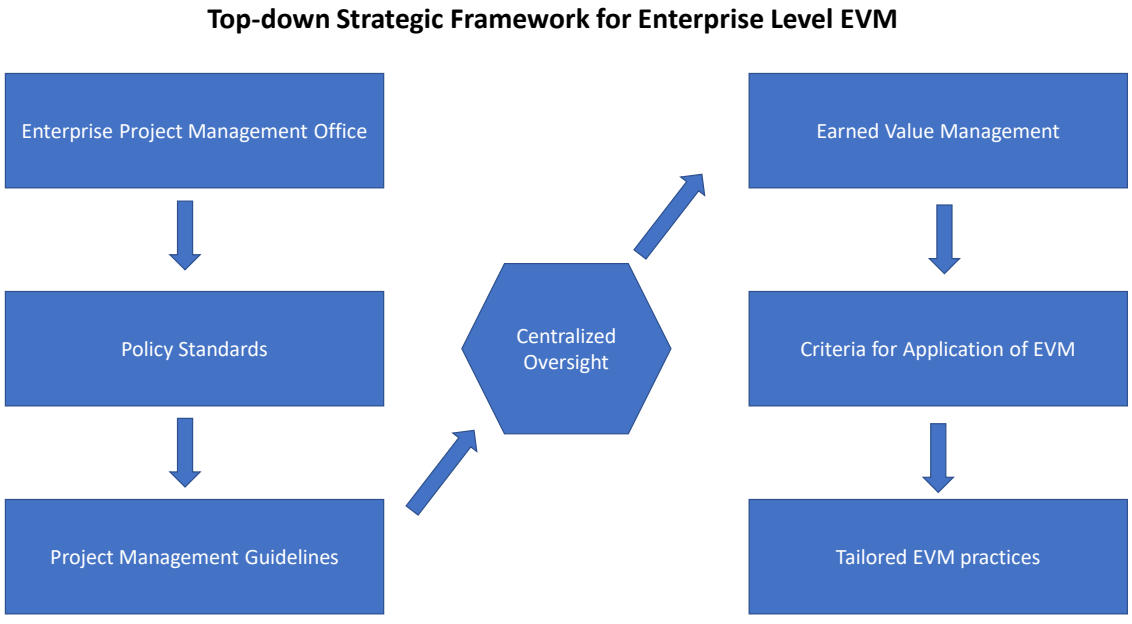


FIGURE 3.1: Top-down Strategic Framework for Enterprise Level EVM

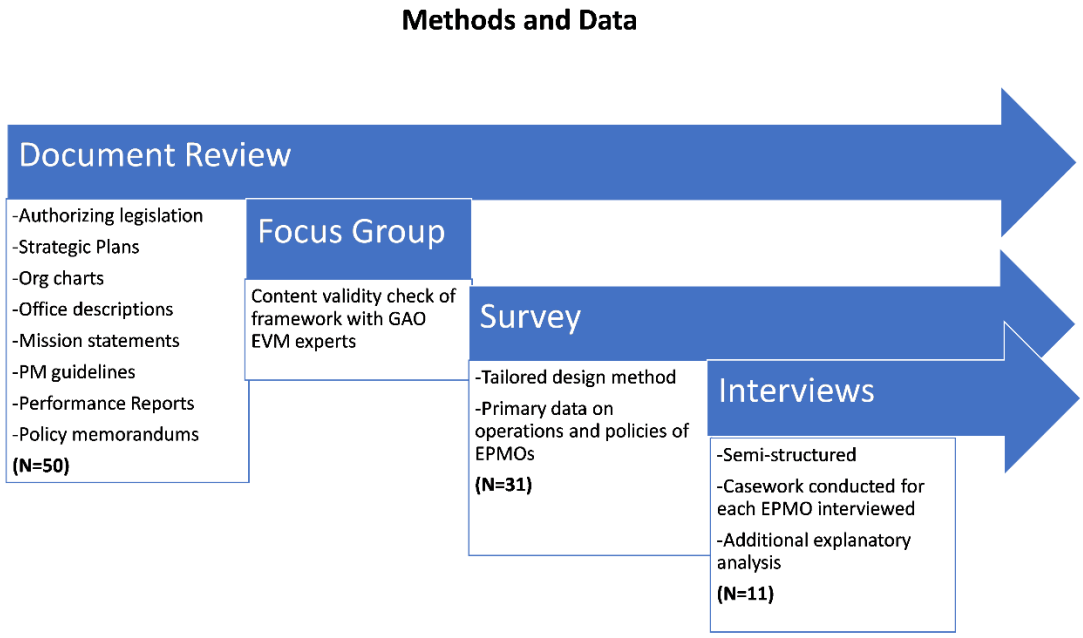
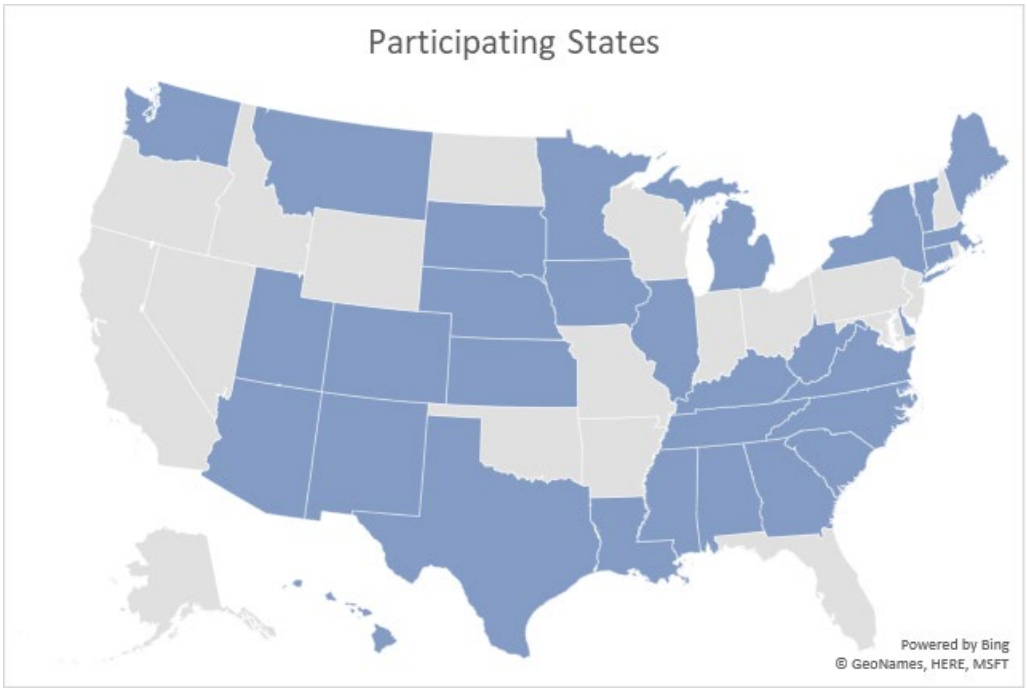


FIGURE 3.2: Methods and Data



***Participating states shaded in blue**

FIGURE 3.3: Participating States*

TABLE 3.1: Nominal Criteria used for Index, Range (0-7)

Element	**Nominal Criteria**
Enterprise Project Management Office	= 1 if state has an EPMO
Policy Standards	= 1 if state uses industry standards
Project Management Guidelines	= 1 if state has defined guidelines
Centralization	= 1 if agencies must follow EPMO guidelines
EVM	= 1 if EVM is currently used
Criteria for Application	= 1 if criteria are defined for application of EVM
Tailoring	= 1 if EVM practices are tailored according to project context

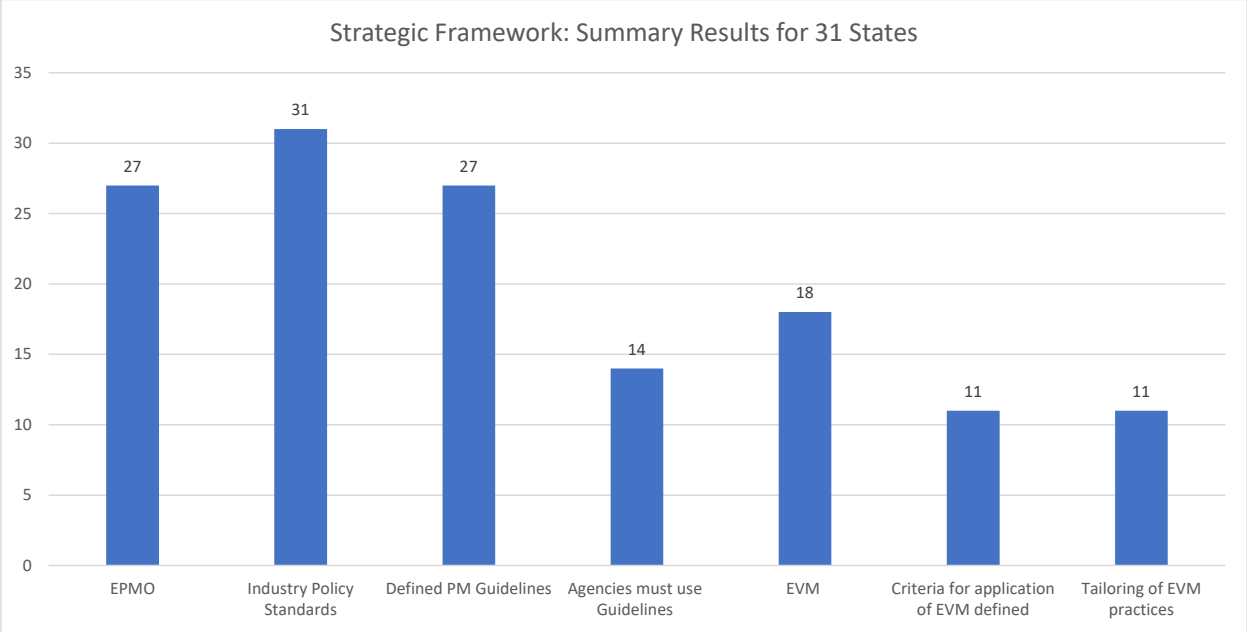


FIGURE 3.4: Summary Results

TABLE 3.2: Detailed Results by State

State	Project Management Office	Industry Policy Standards	Defined PM Guidelines	Agencies must use guidelines	EVM	Criteria for Application	Tailoring EVM practices	Total
Georgia	1	1	1	1	1	1	1	7
Virginia	1	1	1	1	1	1	1	7
North Carolina	1	1	1	1	1	1	1	7
Alabama	1	1	1	1	1	1	1	7
Michigan	1	1	1	1	1	1	1	7
Nebraska	1	1	1	0	1	1	1	6
Texas	1	1	1	1	1	1	0	6
Kansas	1	1	1	1	1	1	0	6
New York	1	1	1	1	1	0	1	6
Kentucky	1	1	1	0	1	1	1	6
Massachusetts	1	1	1	0	1	1	1	6
South Carolina	1	1	0	0	1	1	1	5
Tennessee	1	1	1	1	1	0	0	5
Illinois	1	1	1	1	1	0	0	5
New Mexico	1	1	1	0	1	0	0	4
Utah	1	1	1	0	1	0	0	4
Vermont	1	1	1	1	0	0	0	4
Louisiana	1	1	1	1	0	0	0	4
Colorado	1	1	1	1	0	0	0	4
Connecticut	0	1	1	1	1	0	0	4
Iowa	1	1	1	0	0	0	0	3
Montana	0	1	0	0	1	0	1	3
Arizona	1	1	1	0	0	0	0	3
Hawaii	1	1	1	0	0	0	0	3
Delaware	1	1	1	0	0	0	0	3
Washington	1	1	1	0	0	0	0	3
Maine	1	1	1	0	0	0	0	3
Minnesota	1	1	1	0	0	0	0	3
Mississippi	0	1	1	0	0	0	0	2
West Virginia	1	1	0	0	0	0	0	2
South Dakota	0	1	0	0	0	0	0	1
Total	**27**	**31**	**27**	**14**	**18**	**11**	**11**	

Descriptive Statistics	
Range	1 to 7
Mean	4.5
St. Dev	1.7
Median	4
Mode	3

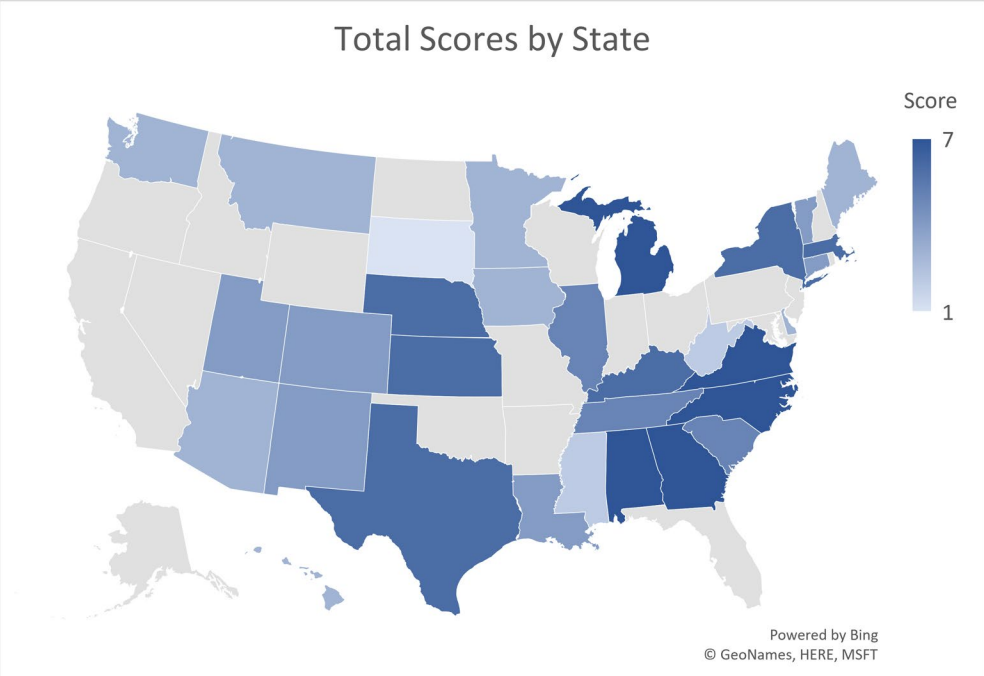


FIGURE 3.5: Total Scores by State

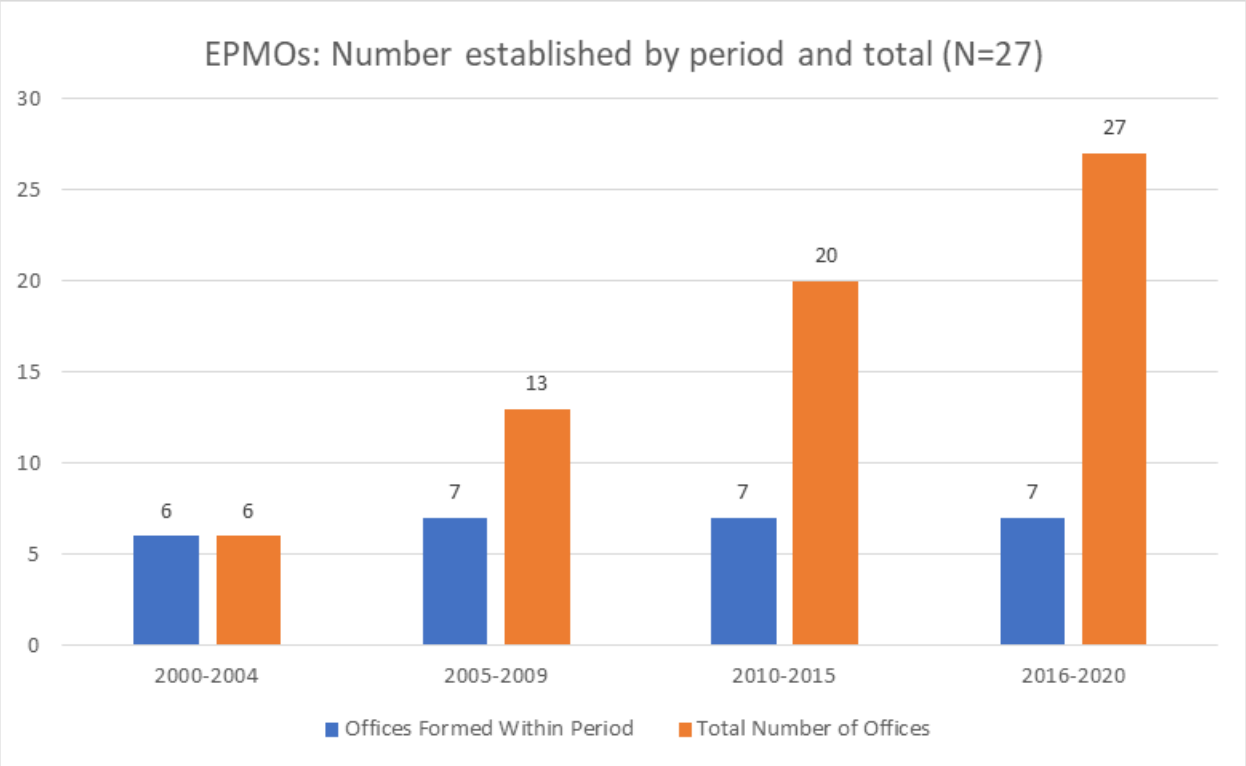


FIGURE 3.6: EPMO Chronology

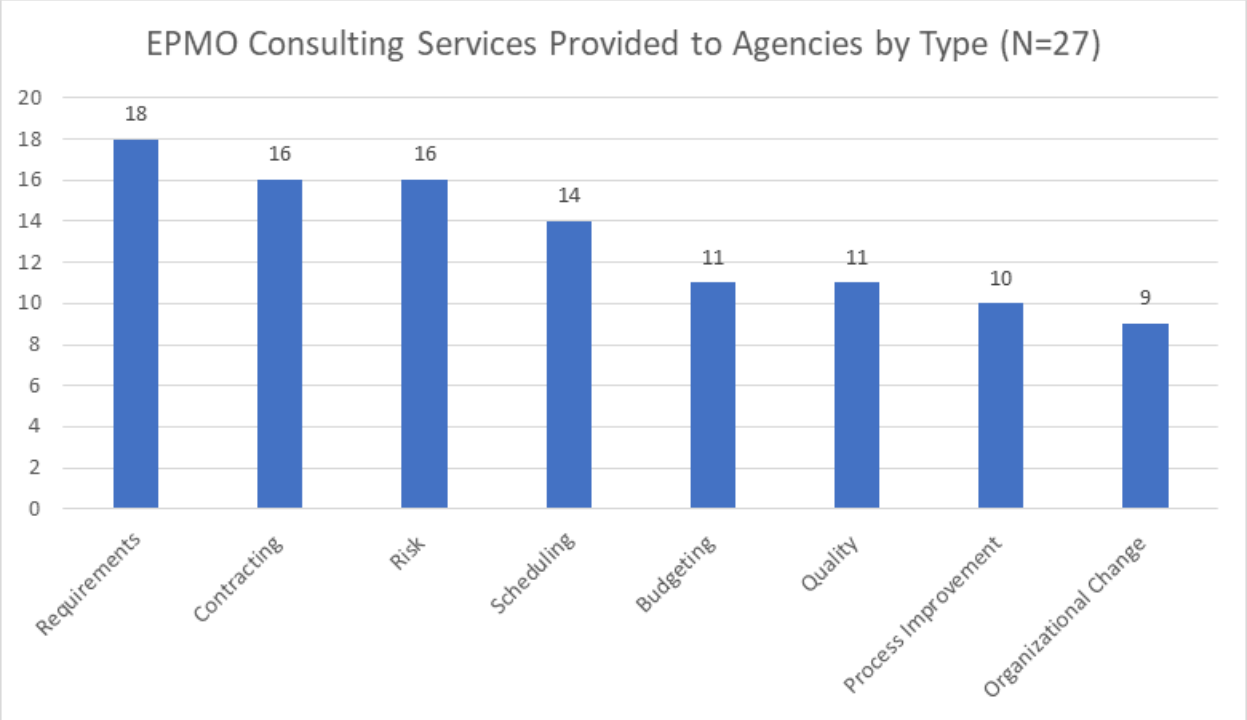


FIGURE 3.7: EPMO Consulting Services Provided To State Agencies

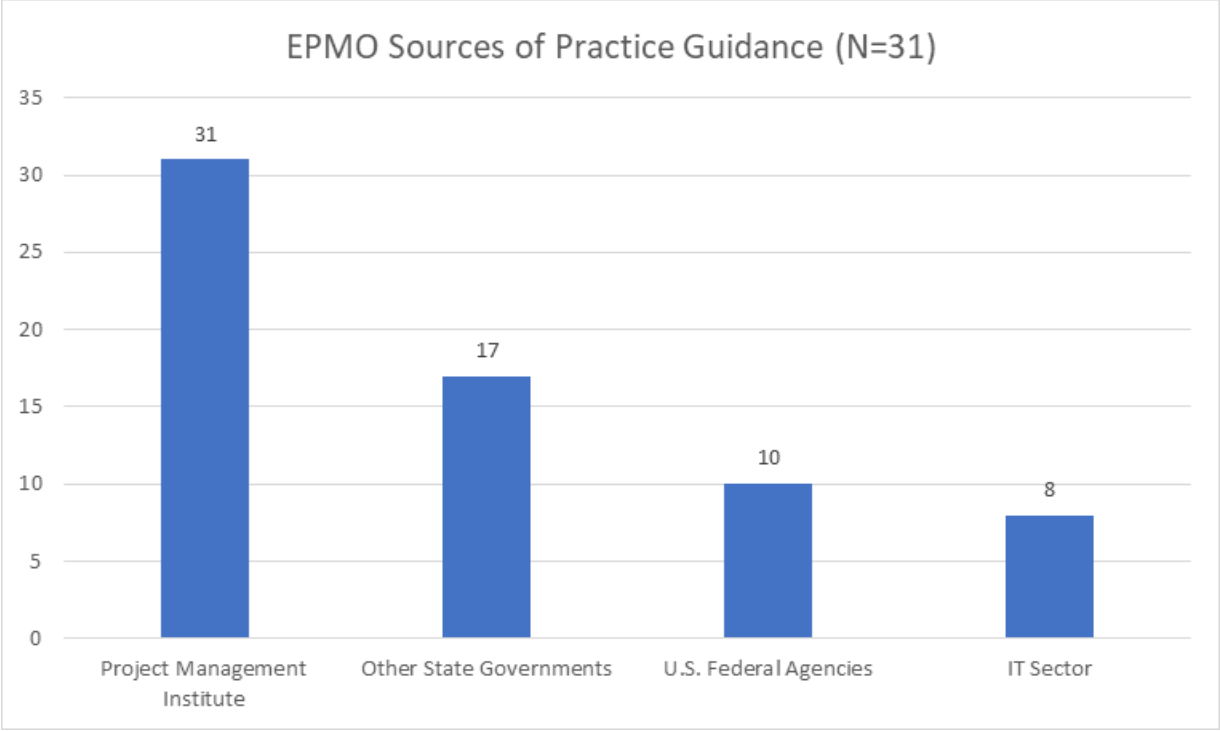


FIGURE 3.8: EPMO Sources of Practice Guidance

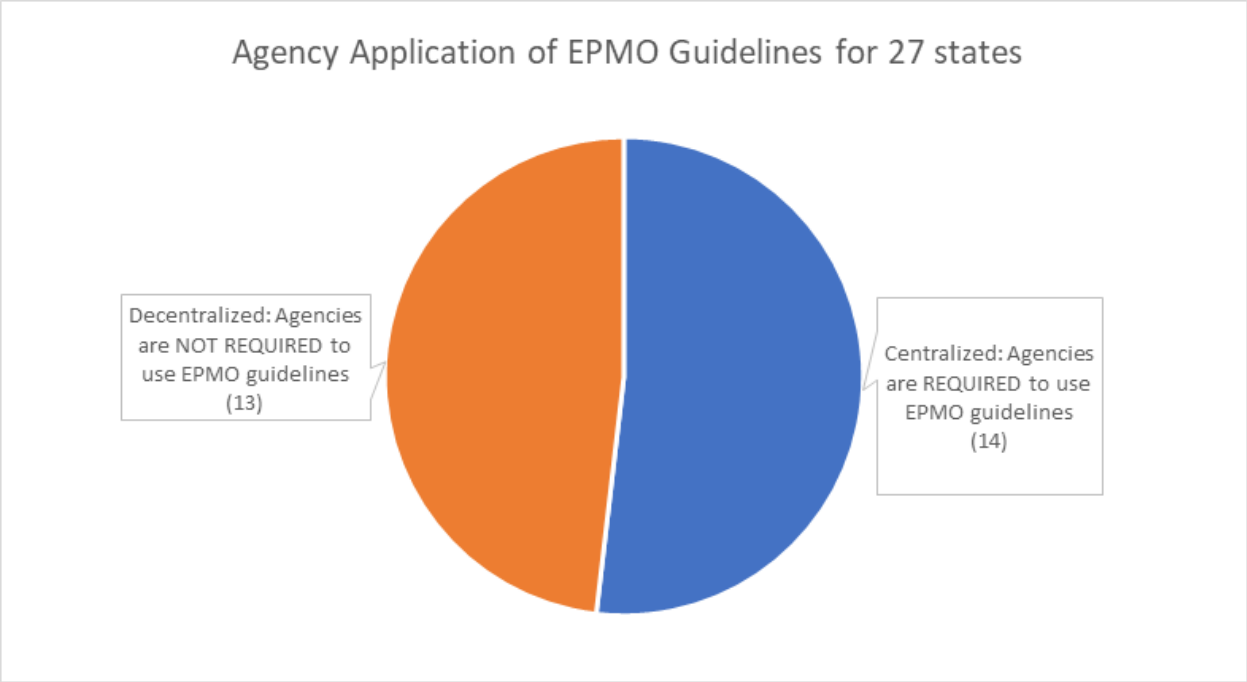


FIGURE 3.9: Agency Application of EPMO Guidelines

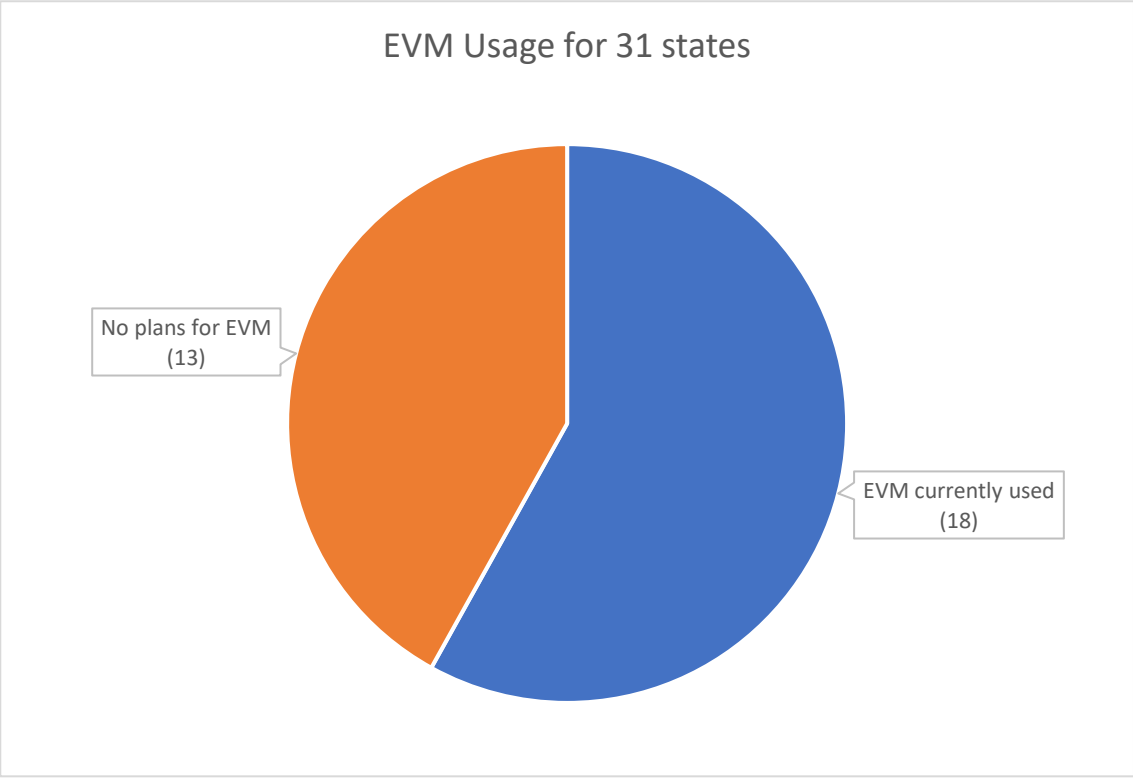


FIGURE 3.10: EVM Usage

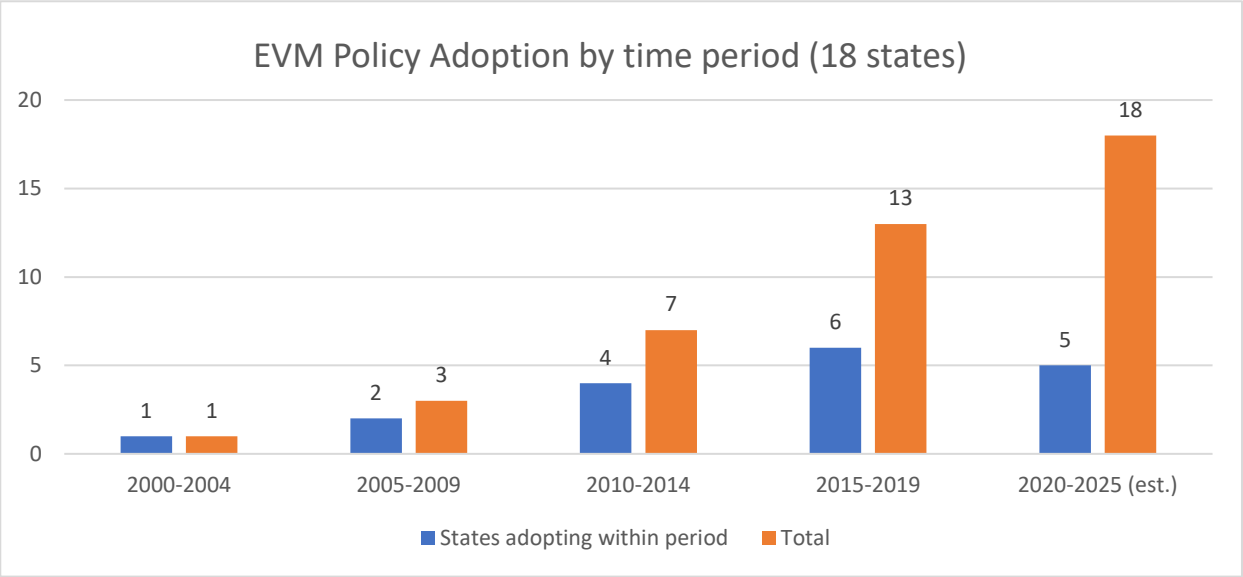


FIGURE 3.11: EVM Chronology*

*Represents when EVM was adopted as policy; five current users will be adopting formal EVM policy in the near future.

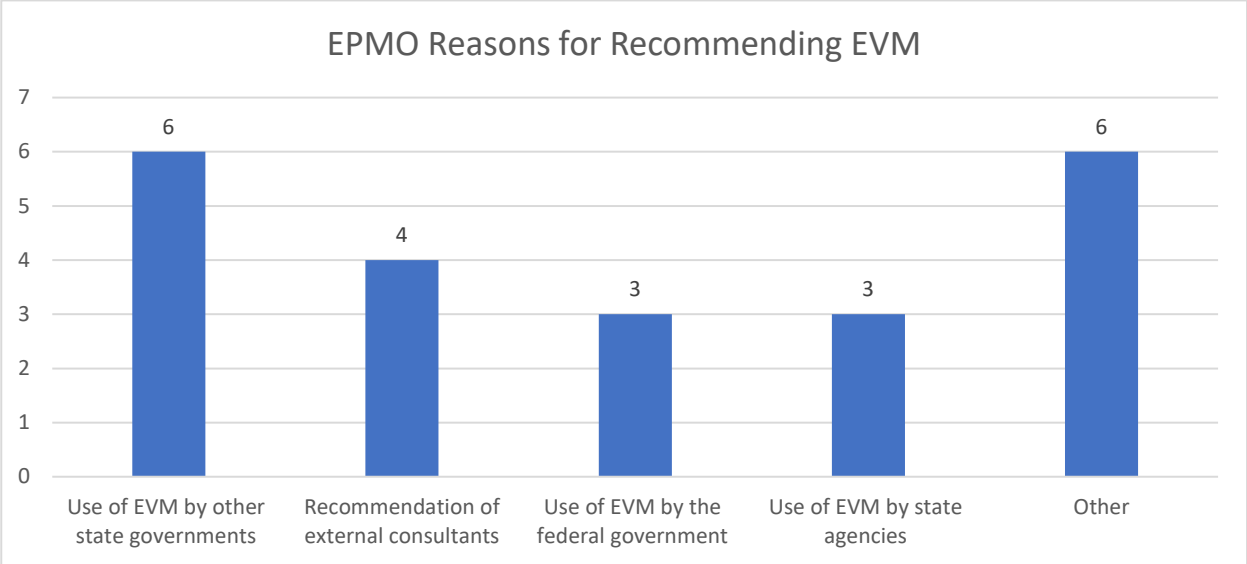


FIGURE 3.12: Reasons for Recommending EVM

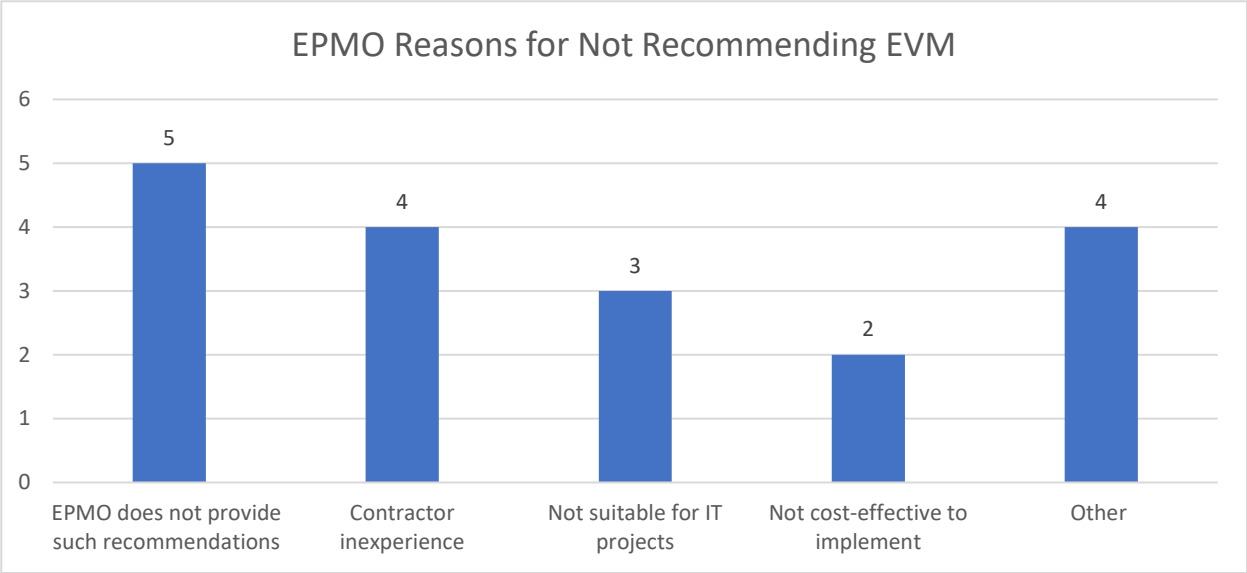


FIGURE 3.13: Reasons for Not Recommending EVM

Criteria for Application/Practices	Tailored per project context	Common procedures
Explicitly defined based on cost, risk, etc.	(9) **Georgia** **Virginia** **North Carolina** **Alabama** **Michigan** Kentucky Massachusetts Nebraska South Carolina	(2) **Texas** **Kansas**
Vaguely refers to "major projects"	(2) **New York** Montana	(5) New Mexico Utah **Tennessee** **Illinois** **Connecticut**

FIGURE 3.14: EVM Strategy Matrix for 18 States*

*States that require agencies to follow EPMO guidelines are **bolded**

CHAPTER 4

EARNED VALUE MANAGEMENT IN THE STATES

In project management, performance is a multidimensional concept, encompassing scope, time, and money. As Chapter 3 explained, performance issues were some of the primary reasons for the adoption of EVM in U.S. state governments for IT projects. In comparison to the U.S. federal government, the brand of EVM practiced in the states is relatively new, flexible, and decentralized. In shifting the focus from adoption to implementation, this chapter answers two primary research questions for IT project management. What are the contributions, if any, to project management from implementing EVM? What factors are critical to effective use of this project management method?

Multiple dimensions of performance are analyzed to determine potential contributions to project management. For example, the research investigates early-warning capabilities for cost-overruns and schedule delays, prevention of scope creep, and achievement of performance objectives. In addition, EVM's ability to promote effective communication among project stakeholders and facilitate corrective action is explored. On factors critical to effective use, elements of the strategic framework presented in Chapter 3 are analyzed to determine their relative importance. The research methods and data involve the use of document review, surveys, interviews, and case studies.

Results from 17 states that currently use EVM indicate that it serves as an effective early warning system for cost overruns and schedule delays, facilitates corrective action, and helps meet cost and schedule objectives. However, certain factors are decisive in realizing these

benefits, such as tailoring practices to fit project context, conducting independent reviews of performance baselines, developing corrective action plans based on EVM indicators, and training programs. These findings align closely with the EVM body of knowledge.

This chapter begins by describing potential benefits of EVM application and the importance of strategy in realizing these benefits. It then outlines the research methods and data used for the analysis. Next, case studies are used to illuminate the experiences of the states. Following this, results explain EVM's contributions to project management and factors critical to effective use for IT projects, using survey results and context gathered from follow-up semi-structured interviews. The paper concludes by integrating findings into the project and public management literatures, focusing on implications for state governments.

Performance and Strategy

Organizational performance is a multidimensional concept (Boyne, 2003; Selden & Sowa, 2004; Talbot, 2010; Walker, Boyne, & Brewer, 2012). As Boyne (2003) has explained, "headline" dimensions of public service performance include the quantity and quality of outputs, efficiency, equity, value for money, and customer satisfaction. Scholars of public management have researched potential sources of improvement in public performance attributable to a variety of factors, such as resources, regulation, market structure, organization, and management (Boyne, 2003; Walker et al., 2012). However, research on strategy and public performance has been relatively limited (Walker, 2012). Regarding capital project management, scholars of public management have yet to study strategies to improve project delivery, aside from suggesting that there are potential advantages of centralized project oversight (Ammar, Duncombe, & Wright, 2001; Ebdon, 2004; Jimenez & Pagano, 2012; Srithongrung, Yusuf, & Kriz, 2019).

Applying this framework to project management suggests three "headline" dimensions of performance: scope, time, and money. Because EVM is a project management strategy intended to improve management of these dimensions of performance, the EVM body of knowledge has serious potential to fill knowledge gaps in public management. As explained in Chapter 2, the body of knowledge points to significant benefits of EVM application, such as early warning of performance issues and more consistently meeting performance objectives (Christensen & Heise, 1993; Christensen & Payne, 1992; Song, 2010; U.S. Government Accountability Office, 1997, 2009a). However, it also indicates that certain factors are decisive in realizing these benefits, such as leadership and organizational culture, the nature of policy, human capital, and training (Christensen, 1998; Kim, Wells Jr, & Duffey, 2003; Song, 2010; U.S. Government Accountability Office, 1997, 2008, 2009a, 2009b, 2012, 2016, 2019).

Researchers of public and project management use both archival and perceptual data in analyzing performance. Archival data provides objective indicators of performance that can be audited, such as quantity of outputs produced or cost per unit. In contrast, perceptual data offers subjective indicators, such as customer satisfaction. An advantage of using archival data is its objectivity; however, limitations arise because it often covers a narrow set of dimensions and may be constrained to only publicly-available data (Walker et al., 2012). Perceptual data can potentially tap into a wider range of dimensions and incorporate the perspectives of key stakeholders, but is relatively subjective and relies on memory recall (Golden, 1992). In public management, researchers have endorsed using both types of data to overcome the limitations of using either in isolation, to better understand performance (Walker et al., 2012).

In project management, researchers have used archival and perceptual data to analyze potential contributions to project management from EVM and factors critical to effective

implementation. Regarding contributions to project management, research using archival data has demonstrated EVM to be an effective early-warning system for cost-overruns and schedule delays (Batselier & Vanhoucke, 2015; Christensen & Heise, 1993; Christensen & Payne, 1992; Fleming & Koppelman, 2010; Willems & Vanhoucke, 2015). Importantly, research using perceptual data to assess such early warning capabilities is consistent with these findings (Kim et al., 2003; Song, 2010). Most evidence of EVM contributing to actual improvements in project delivery comes in the form of perceptual data (Kim et al., 2003; Song, 2010). As explained in Chapters 2 and 3, archival research must establish a measurement of EVM, such as the one provided in Chapter 3, to examine the relationship between usage and improved project delivery. Nevertheless, as GAO and PMI have noted, perhaps the strongest evidence that EVM can improve project delivery is simple—firms began using a lighter version of EVM voluntarily in the early 1990s for their own commercial projects, and continue to invest in EVM systems to improve project delivery (Fleming & Koppelman, 2010; Project Management Institute, 2017; Song, 2010; U.S. Government Accountability Office, 1997).

This work emphasizes that research on EVM in the public sector has focused exclusively on national governments, mostly the U.S. federal government. Additional research is needed to better understand how project characteristics complicate or simplify EVM implementation. For example, it may be the case that the iterative nature of scope definition in IT project management complicates implementation, requiring specific tailoring to realize benefits of EVM. Therefore, to fill these gaps in the public management literature, research is needed to understand how EVM performs in state government and within different project environments. To fill these knowledge gaps, this chapter examines potential contributions to project management from EVM and factors critical to effective implementation for IT projects in state government.

The left side of Figure 4.1 lists the potential contributions to project management from EVM that are analyzed: early warning of cost and schedule performance issues, prevention of scope creep, improved communication, opportunity for corrective action and mitigation of risk, and more consistently delivering projects on time and on budget. These potential contributions tap into multiple dimensions of performance and may demonstrate a sequential logic among early warning, corrective action, and improved project delivery (see right hand side of Figure 4.1). EVM may be more effective for some dimensions of performance (managing costs) than for others (schedule, or vice versa). Concerning sequential logic, it could be that EVM consistently provides early warning of performance issues, but that actual improvements in project delivery are much less common. Nonetheless, it is critical for policymakers to have a better understanding of the actual benefits, if any, of EVM application for IT projects in state government.

The strategic framework from Chapter 3 is expanded and put to the test to determine factors affecting EVM implementation. Specifically, the relative importance of several organizational, policy, and human capital elements are analyzed (see Figure 4.2). The establishment of Enterprise Project Management Offices (EPMOs) and conduct of centralized oversight are examined to determine organizational effects. The study investigates policy effects through the adoption of industry standards, tailoring of procedures to fit project context, performance baseline review, and linkage of corrective action plans to EVM indicators. Finally, as for human capital, the roles of certified Project Management Professionals (PMP), EVM training programs, and contractor experience are explored. As described in Chapters 2 and 3, the research findings establishing the importance of these factors for effective EVM implementation are predominately GAO case studies of U.S. federal agencies and PMI-sponsored survey

research of EVM users (Kim et al., 2003; Song, 2010; U.S. Government Accountability Office, 2009a, 2010, 2012, 2015, 2016).

In summary, the EVM body of knowledge provides compelling evidence for its contributions to project management and factors critical to effective implementation. However, no research has examined EVM in state and local governments, limiting our understanding of its potential to improve project delivery for a wide range of costly public infrastructure projects with prolonged durations. The following section explains the research methods and data used to conduct original research on EVM in U.S. state governments.

Methods and Data

The research design employed is the same one from Chapter 3, with the addition of case studies. As Figure 4.3 shows, it involves the use of document review, a focus group, implementation of an electronic survey and telephone interviews, and case study analysis. Chapter 3 provided a detailed description of how the design was developed and used to analyze the adoption of EVM. Therefore, this section provides a brief recap of the design, focusing instead on how it is used to investigate potential contributions to project management from EVM and factors affecting implementation.

An electronic survey was developed to obtain primary data from state governments on their EPMOs, project management guidelines, and the application of EVM. Development of the survey was guided by document review and previous EVM survey research sponsored by PMI (Kim et al., 2003; Song, 2010). To incentivize response, a social exchange strategy was utilized (Dillman, Smyth, & Christian, 2014). Specifically, in exchange for their participation, respondents were offered a copy of research findings and invited to attend a collaborative webinar. This yielded responses from 31 states; however, three did not fully complete the EVM

section of the questionnaire. A total of 11 semi-structured interviews were conducted as follow-up to the survey to provide additional context to results. The same informants that completed the survey participated in the interviews. Finally, case studies of three state EPMOs were completed to illuminate unique experiences and provide a comparative analysis.

Study participants, officers of EPMOs, are well-experienced: 60% have worked in project management for over 10 years, and 25% have more than 20 years of experience. Almost half of the participants have more than 10 years of specific experience in IT project management in state government. Approximately half of participants are certified Project Management Professionals (PMP). Thus, their perspectives provide rich insight for this study.

As Figures 4.4 and 4.5 show, the survey uses a series of Likert scale questions to obtain perceptual data on contributions to project management from EVM and factors affecting implementation. The question stems were written to ensure that responses captured perceptions specific to IT project management in state government. In both cases, a five-point response scale was used, with labels indicated for each point on the scale, in order to provide adequate sensitivity of measurement and comparability with previous EVM survey research. Specifically, research suggests that data from Likert items may lose validity if the number of scale points is less than five or greater than seven (Colman, Norris, & Preston, 1997; Johns, 2010; Miller, 1956). Regarding comparability, previous EVM survey research has utilized five-point scales in studying these contributions to project management and factors affecting implementation (Kim et al., 2003; Song, 2010). [13]

The follow-up semi-structured interviews provide explanatory data for the Likert responses and relationships among them. Regarding contributions to project management,

[13] In addition, steps were taken to ensure all questions were easy to answer on cellphones.

participants were first asked to provide context on their ratings for individual components before explaining their overall rating. Prior to each interview, survey responses were reviewed to determine areas of focus for individual components. For example, if a respondent indicated that EVM performed better for cost than schedule, they were asked why. To discover potential relationships among contributions, respondents were asked to provide examples of early warning indicators facilitating corrective action that helped meet performance objectives, consistent with the sequential pattern indicated in Figure 4.1. Respondents were asked to explain the relative importance of factors affecting implementation, and how these contributed to effective conduct of EVM in their state. For instance, if a respondent indicated that tailoring of procedures was extremely important, they were asked which modifications from industry standards were critical.

The final component of this research design involves three case studies of state EPMOs, included to provide context on the primary research questions. Each case chronicles the origin and evolution of EPM in each state, with special attention to the application of EVM. Regarding the selection of cases, consideration was limited to state EPMOs that participated in telephone interviews that currently use EVM. The data collected from the document review and interviews in each state helped select among those nine state EPMOs. Some states are more transparent than others and provide a more comprehensive set of documents to analyze and synthesize, and some participants have more institutional memory than others and disclose more information. Based on this, a few strong candidates emerged, with Alabama, Georgia, and New Mexico selected.

Case Studies

New Mexico

New Mexico scored 4 out of 7 on the strategic framework. The three missing components of their EPM strategy are centralization, criteria for EVM application, and tailoring of EVM

practices. For centralization, agencies and their individual project managers are given broad discretion in managing their projects. The EPMO issues a set of optional project management guidelines that call for use of EVM. Thus, analysis of New Mexico provides the opportunity to examine decentralized EVM application. In addition, it provides an example of an EPMO that is heavily involved in budget preparation and approval.

New Mexico exemplifies the factors leading to IT project management reforms in state government discussed in Chapter 3. The state is extremely transparent in documenting its history, providing the public with an "EPMO Journey Map" (see Figure 4.6) that chronicles its origin and evolution. In response to costly IT projects "expending large sums of money with minimal results" (State of New Mexico Legislative Finance Committee, 2008) and "project failures" (State of New Mexico Department of Information Technology, 2015), the state began to enact reforms to improve project delivery. The EPMO Journey Map describes one of the Legislative Finance Committee's reports as "scathing," attributing performance issues and project failures to weaknesses in governance and management. Following this, a series of reforms, enacted from 2007 to 2011, involved the establishment of industry standards, issuance of project management guidelines, and new conduct of oversight. The initial focus of the EPMO was relatively top-down, aimed at ensuring compliance with new mandates. In 2011, the EPMO was rebranded to focus on becoming a trusted partner in capacity building by providing "holistic, non-threatening, mentoring and coaching guidance" (State of New Mexico Department of Information Technology, 2015).

The EPMO is involved at each stage of the budgeting process. Regarding budget preparation and approval, the EPMO works with agencies to develop their proposals and makes recommendations to the Governor's Office as the governor's budget recommendation is

considered by the legislature, then makes recommendations to the legislature on specific projects and dollar amounts. The EPMO contributes to budget execution by conducting assessments of agency readiness at major project gates. If deficiencies are identified, agencies must resolve them before the EPMO releases funding. Agencies are given discretion in determining when to use EVM, with the final decision described by the officer as being "project manager dependent."

EVM was adopted during the "directive" stage of the EPMO evolution (see EPMO Journey Map), primarily due to its status as a PMI best practice and a need to improve project delivery. New Mexico did not cite use of EVM by other states, their own state agencies, or the U.S. federal government in contributing to the decision to adopt the practice. Following adoption, some project managers in the Taxation and Revenue Department (TRD) and Department of Transportation (DoT) began using EVM for major IT projects. Both are good candidates for EVM usage, because of the sheer cost of their projects and management capacity. Over time, they learned how to use EVM to better position themselves to achieve their performance objectives.

Because agencies and project managers are given discretion in determining when to use EVM, the EPMO has experience working with both EVM users and non-users. As the officer noted, "a project using EVM is more likely to be aware of their project status and to communicate and meet its technical, schedule, and cost objectives than a project that does not."[14] Importantly, because agencies must demonstrate readiness at major project gates to secure funding, this provides the EPMO an opportunity to intervene with authority during project execution, despite EVM not being a firm requirement.

[14] Response to open-ended question of electronic survey.

There are no major changes regarding future use of EVM planned at this time. However, the officer shared their perspectives on a couple of items, and indicated that they would encourage expanded use of EVM. Given effective application of the practice on specific projects, lessons learned can be leveraged to improve project delivery. Another topic of conversation was the establishment of EVM training programs. When asked about the prospects of creating such programs, the officer indicated that this is something they would encourage.

Georgia

Georgia scored 7 out of 7 on the strategic framework, with all of the elements currently in place. In contrast to New Mexico, project delivery is centralized in Georgia. Agencies are required to follow guidelines specified by the EPMO, one of which calls for EVM on major projects. Use of EVM in Georgia is relatively advanced, with unique participatory evaluation techniques implemented to ensure the EPMO has a true picture of project status. The EPMO in Georgia is oriented towards project delivery, with relatively little involvement in budget preparation and approval. Therefore, analysis of Georgia provides the chance to analyze centralized project execution and advanced EVM in comparison to other states.

Like many state governments, Georgia enacted reforms to improve project delivery in the early 2000s, in response to schedule delays, cost overruns, and the acquisition of IT systems that failed to completely meet business needs (Georgia Technology Authority, 2009). In 2004, the state centralized project management by establishing an EPMO, adopting PMI standards, and issuing project management guidelines. To focus on the most significant risks in their portfolio, the EPMO established the Critical Project Review Panel shortly thereafter. The purpose of the panel is to engage in monthly reviews with all key stakeholders and proactively manage risks. For Fiscal Year 2019, the panel has focused on a portfolio of 10 projects that total $318 Million.

In preparing for the challenges of enormous acquisitions, a Large IT Project Executive Decision-Making Board was established in 2017. The officer explained that this board has ultimate decision-making authority for acquisitions costing more than $10 million.

The EPMO in Georgia is involved more intensively in the budget execution phase than in preparation and approval. For example, the EPMO works with agencies in developing their strategic IT plans and conducting business case analysis. However, the Governor's Office of Planning and Budget is ultimately responsible for budget preparation, and the EPMO does not advise the legislature on project selection in the same way as New Mexico. Regarding execution, agencies are required to follow EPMO guidelines, which specify use of EVM. The EPMO provides criteria to agencies for determining when to use EVM based on cost, duration, and risk.

Of the states surveyed, Georgia was the first to adopt EVM, in 2004, concurrent with the establishment of the EPMO to help improve project delivery. Notably, Georgia cited use of EVM by the federal government as a reason for adoption. Prior to the EPMO's adoption of EVM, state agencies were not using it to manage their projects. In the mid-to-late 2000s, there was a gradual increase in the number of users as EVM was rolled out. At present, EVM is used on most major projects. Their current EVM strategy focuses on tailoring practices according to project context and agency maturity in the use of the practice. Regarding the operating environment, like many states, Georgia's EPMO faces pressure to meet "aggressive deadlines" set by their governor (The Strategic CIO, 2014). For this reason, the EPMO established SPI as a key performance indicator for state agencies. To be clear, cost metrics are also closely monitored. However, the officer emphasized the use of EVM time metrics, such as SPI, in striving to meet deadlines.

The case of Georgia illustrates the importance of investing in a cutting-edge portfolio management reporting system (The Strategic CIO, 2014). The Georgia Enterprise Management

Suite (GEMS) provides a performance dashboard for each major project. GEMS, like most project reporting tools, was built to import agency data to analyze EVM indicators. Uniquely, GEMS was designed to receive input from multiple stakeholders, facilitating a collaborative evaluation process. For example, GEMS does not simply report SPI and accompany it with a status report from the project manager. It surveys project team members to capture their perceptions regarding project status and risk. Example questions are provided in Figure 4.7. This enables the EPMO to compare the EVM time metrics reported by the project manager and accompanying analysis to the perceptual team data. If EVM indicators and the survey results align, this lends confidence to the status provided by the project manager. In other instances, this participatory evaluation process is capable of detecting problems that may not be detected or reported solely by the project manager. Thus, GEMS paints a more complete portrait of project status, enabling the EPMO to intervene more effectively than it would with status reported strictly by the project manager.

When asked to share key lessons learned from this participatory evaluation process, the officer pointed to the need to start simple, build out from where you are, and focus on change management (The Strategic CIO, 2014). While project managers are accustomed to owning the reporting of project status, the officer explained, resistance to the change lessened as the tool was implemented, as it helped project managers identify communication issues and receive input from multiple stakeholders (The Strategic CIO, 2014).

Alabama

Alabama also scored 7 out of 7, with all strategic elements reported to currently be in place. However, despite the strong policy score, use of EVM in Alabama is inconsistent. As an officer from the state noted, “EVM is currently required by policy for projects meeting the

criteria . . . However, many agencies do not comply." In contrast to Georgia and New Mexico, reforms in Alabama are fairly recent, beginning in earnest in 2013 and encompassing project selection and delivery. Since then, the state has significantly improved project selection, but improvements in project delivery remain uneven across agencies. In order to realize benefits of EVM application more consistently, certain agencies need to become more proficient in core project management areas. Thus, Alabama is useful for illustrating the benefits of centralized budget preparation. At the same time, it shows the pitfalls of imposing EVM requirements on agencies who lack familiarity with the practice.

Reforms in Alabama dealt with both the need to centralize responsibility for budget preparation and improve project delivery. As an officer from the state described, with a few exceptions, agencies did not typically include formal analysis for alternatives, compatibility, risks, or return on investment for their IT projects. In 2013, legislation was passed that required agencies to standardize their requests, inclusive of cost-benefit analysis and compatibility review. Shortly thereafter, the EPMO provided templates to produce these artifacts. In speaking to the results of these changes, an officer shared that:

> Key stakeholders are more confident in their financial decisions, they have a much better understanding of the costs and expected benefits, and the artifacts produced communicate to all stakeholders a consistent message of why the initiative is necessary and documents a clear project scope. The business case and CBA serve as justification for budgeting and financial management. By requiring these artifacts, agency stakeholders must invest the effort to examine the problem thoroughly and justify their decision based on business value, costs, risks, security, and compatibility. This is something that many agencies simply did not take the time do before.

Regarding project delivery, Alabama experienced a project failure that served as momentum for reform. The Centralized Alabama Recipient Eligibility System (CARES) was intended to allow multiple state agencies to interact with individuals who qualified for state and federal benefits. According to the Alabama Political Reporter, after a $20-$40 million investment in CARES, the complex system was found to be inoperable (Britt, 2016). An evaluation found that, in additional to technical issues, the project team lacked proper budget controls and the ability to "clearly communicate the status of the actual vs. approved budget to the stakeholder financial staff." [15] Following this, the EPMO issued project management guidelines in 2016, with the requirement that all executive agencies follow them.

EVM was adopted concurrent with the establishment of project management guidelines in 2016. In developing EVM policy, Alabama used PMI practices and guidelines from other states, citing federal standards as unnecessarily complex. The EPMO provides criteria for agencies to determine when to use EVM based on cost, risk, duration, and the number of agencies impacted. The officer described their initial rollout of EVM as "guns blazing," introducing a process that some state agencies had not practiced before and did not have the maturity to implement. The initial rollout exposed weaknesses in core competencies for some agencies regarding project scheduling, cost-estimation, and risk management—competencies that are prerequisites for effective conduct of EVM.

On the other hand, agencies with higher levels of maturity in these competencies have been able to use EVM effectively, with one EVM success story providing a blueprint. Prior to

[15] Internal review obtained by Alabama Political Reporter: https://www.alreporter.com/media/2016/09/1aCARES-Assessment.pdf

the adoption of project management guidelines and EVM, an agency escalated a project to the EPMO following the agency's rejection of costly vendor deliverables. EVM was one of many approaches utilized to stabilize the project, providing the EPMO measurements agreeable to both the state and the vendor as the contract was renegotiated. Ultimately, the EPMO educated the agency on how EVM can serve as an effective early-warning system for both vendor and project performance, positioning them to avoid these circumstances on future projects.

In Alabama, EVM is currently applied by agencies that have the need, and the maturity, to execute it. The EPMO plans on continuing to educate agencies on effective practices in the future, such as EVM; however, as the officer explained, the EVM strategy in the future will be less aggressive than the initial rollout. Specifically, because they lack a true enforcement mechanism, they will focus on demonstrating the value of EVM and "let [agencies] come to the table" once they better understand its benefits.

Results

This section is organized into two parts: contributions to project management from EVM and factors affecting implementation. The first part provides results for contributions to project management from EVM, first by providing an overview of results, and then explaining findings for specific components. Frequency tables are used to show the distribution of Likert responses. The ordinal Likert responses were converted to numerical scores to facilitate a quantitative analysis of central tendency and dispersion. In discussing findings for specific components, the interviews and open-ended survey responses provide explanatory context. The second part provides results for factors affecting implementation and follows the same cadence as the first part explained above.

Contributions to Project Management

Table 4.1 provides a frequency tabulation for 17 EVM users, with the median response indicated in bold. With the exception of preventing scope creep, most respondents "agree" that EVM provides several contributions to IT project management in state government. Table 4.2 gives measures of central tendency and dispersion for each of these potential contributions. A visualization provided in Figure 4.8 graphs the mean and plots an error bar that is plus or minus one standard deviation from the mean. This part of the section now provides analysis of results for individual components.

Early Warning and Scope Creep. To determine EVM contributions to early warning, interviews focused on understanding two general uses of the data forthcoming with EVM application: variance analysis of performance to date and forecasting. Concerning variance analysis of performance to date, participants explained that EVM provides a reliable set of metrics that can be analyzed monthly. In addition, its detailed reporting structure enables project managers to pinpoint the component of the project at variance with plan.[16] In this regard, EVM's constant generation of metrics and their visibility are advantageous for analysis of performance to date. To measure contributions to forecasting, interviews gathered information on how EVM metrics were used to estimate total project costs and duration. For both cost overruns and schedule delays, interviews focused on understanding what types of indicators were used, how they influenced decision making, and why they were considered effective or not.

[16] Recall from Chapter 2 that EVM uses a Work Breakdown Structure (WBS) to decompose projects into logical groupings and assign responsibility for components of the project. This allows for tracking of variance by deliverable, function, etc. In the document review, it was discovered that all guidelines called for WBS. Therefore, interviews conducted for this research focused very little on reporting structures, instead focusing on metrics and thresholds.

Regarding cost overruns, 12 of the 17 respondents either agree or strongly agree that EVM is an effective early warning system for such performance issues, with an average rating of 3.94 out of 5. Nebraska provides a representative case of how the Cost Performance Index (CPI) is used as a key performance indicator.[17] In Nebraska, if the CPI drops below 0.9, meaning that for each $1.00 spent only $0.90 is earned, projects are flagged and adjustments are considered. The detailed reporting structure of EVM helps pinpoint the source of the variance and facilitate discussions regarding its cause, potential impacts, and adjustments. However, before EPMOs use the CPI to create an Independent Estimate at Complete (IEAC), projects are typically at least 15-20% complete. A few officers explained in interviews that they preferred to give projects time to stabilize before using EVM indicators to develop financial forecasts. In this regard, EVM was described by several as extremely useful for analyzing cost performance in real time. However, its dependency on the stability of project data for estimating total costs can be a limitation.[18]

Concerning schedule delays, 14 of 17 respondents agree that EVM gives early notification of these execution problems, with an average rating of 3.82 out of 5. Several interviews found use of the Schedule Performance Index (SPI) as a key performance indicator. Returning to Nebraska, if the SPI for a project drops below 0.9, projects are flagged and modifications are considered. Similar to the use of CPI in forecasting cost, use of SPI for estimating project duration takes place once projects stabilize. Here again, EVM is considered by many state officers to be very effective at assessing performance to date but needing stable project data for purposes of prediction. An officer from Nebraska commented that:

[17] Please see the example EVM application in Appendix A.
[18] Recall from Chapter 2 that the IEAC is more of a communication tool than forecast because it forces project teams to explain why past performance will be different than future performance for specific components of the project.

> We've have had several projects that we successfully achieved all objectives of projects. Those projects were successful because of proper planning. When performance measures for the costs criteria or schedule criteria reach thresholds, then adjustments were made.

Only seven of 17 respondents agree that EVM helps prevent scope creep, giving it the lowest average rating for all individual components, 3.12 out of 5. An officer indicated that variance reporting may detect work being performed that is not under contract. However, most officers interviewed simply did not view EVM as a scope management tool, and used other strategies to ensure all project stakeholders share an understanding of what needs to be delivered.

Communication and Corrective Action. For portfolio reporting, 13 of 17 respondents strongly agree or agree that EVM indicators are effective for communicating project status in portfolio management, with an average rating of 3.88 out of 5. At the summary level, several respondents explained the importance of a common and objective set of metrics being used in portfolio reporting. For example, prior to reforms in Alabama, project managers were given discretion in how they reported status for budget using stoplight charts. In one instance, such discretion obscured early warning information that EVM data would have easily provided, that may have helped shut the project down earlier and cut losses. A similar case was reported in Georgia. In New Mexico, where agencies are given broad discretion in using EVM, the EPMO finds it easier to communicate with and assist EVM users because they tend to better understand their true project status and potential risks. In contrast, in Georgia, where EVM is required, EVM indicators drive communication, illustrating that such procedures have improved their ability to adjust in real-time by incorporating perspectives of multiple stakeholders. When asked about the importance of portfolio reporting and benefits of using EVM indicators, an officer from Kentucky noted, "Understanding the inventory of IT projects upon which reporting can be

established allows the creation of enterprise reports digestible at the agency or enterprise level, including project financials. Visibility into this information drives questions."

Thirteen of 17 respondents either agree or strongly agree that EVM helps facilitate corrective action, with an average rating of 3.82 out of 5. Interview participants were asked to explain how EVM indicators, such as CPI and SPI, were used to inform the development of corrective action plans. An emerging pattern suggests use of EVM indicators to justify adding time or money to ensure that agency projects deliver their full technical scope. For example, an officer from Illinois reported in the survey that they have "been able to use EVM as a way to justify additional procurement activity or budgetary needs in planning as opposed to leveraging the emergency process." In a few select cases, EVM was one of many factors considered in cancelling projects. For example, an officer from Texas reported in the survey, "Use of EVM helped the project oversight team decide that a project was unsustainable and that it was better to cancel a project rather than to add millions more in budget and extension of schedule."

Achievement of Performance Objectives. Another general pattern that emerged was use of EVM indicators to catch problems early and adjust to meet cost and schedule targets. As the officers of a few EPMOs explained, EVM is critical for meeting cost and schedule objectives simply because it enables their real-time tracking. Without EVM, project teams may not understand the true status of their projects, limiting their ability to mitigate risk or implement corrective actions to meet their performance targets. Regarding cost objectives, 13 of 17 respondents agree that EVM helps realize such targets, with an average rating of 3.76 out of 5. Again, interview participants explained that EVM was very effective in identifying specific components of projects experiencing overruns, and their respective causes, and facilitating

adjustments. The case of Alabama demonstrated that EVM was used successfully to stabilize a project, both as a contracting and project management tool.

Concerning the achievement of schedule objectives, 15 of 17 respondents agree or strongly agree that EVM assists in meeting such targets, giving it an average rating of 3.88 out of 5. Generally, participants explained that EVM helped achieve schedule objectives by establishing measures of progress, identifying delays, and justifying additional budget to reduce anticipated delays. As the case study of Georgia explained, the EPMO is responsible for helping agencies meet aggressive deadlines, and EVM is a key performance indicator. The EPMO uses the SPI to determine projects to flag for review and consideration of corrective action. Over time, certain agencies have become more effective using EVM, which helped them meet deadlines.

Overall. Overall, 15 of 17 respondents agree or strongly agree that EVM is an effective performance management tool. Notably, the overall rating has the highest average score, 4.0 out of 5. Essentially, results in Table 4.1 show that, with the exception of preventing scope creep, most officials using EVM agree that its practice provides several contributions to IT project management in their state government. Thus, the favorable overall rating is reflective of its ability to provide early warning of cost overruns and schedule delays, facilitate corrective action, and help achieve performance objectives.

Factors Affecting Implementation

Table 4.3 provides a frequency tabulation for 16 respondents that use currently use EVM, with the median indicated in bold.[19] As it shows, the factors are typically described as very important for successful implementation of EVM. Table 4.4 presents measures of central tendency and dispersion for each of these factors. The visualization provided in Figure 4.9

[19] The number of responses here is one fewer than the previous section because Montana only partially completed the EVM questionnaire. However, Montana participated in a telephone interview.

graphs the mean and plots an error bar that is plus or minus one standard deviation from the mean. This part of the section now provides analysis of results for individual components.

Organization. Nine of 16 respondents rated the establishment of a centralized project management office as very or extremely important, resulting in an average rating of 3.75 out of 5. As explained in Chapter 3, central offices have been key in leading and managing reforms across state agencies, including EVM. In interviews, state officials explained the importance of establishing accountability, discipline, and consistency in project delivery, while becoming a trusted partner in building agency capacity. Critically, if central project management offices adopt too much of a command and control orientation, changes could be met with significant resistance. For example, in Montana, the initial EPMO reforms, including EVM, were considered to be too top-down and ultimately led to the collapse of their central office. As the case study of New Mexico illustrates, the EPMO evolved from a control orientation to management following pushback from agencies. As the officer from Virginia explained, it is critical for the central office to move beyond simple oversight, to become a trusted partner in building agency capacity by providing training and consulting services.

Policy. Regarding the adoption of industry standards, eight of 16 respondents indicated this was extremely or very important, with an average rating of 3.44 out of 5. Interview participants explained that the adoption of industry standards was a critical first step to EVM traction. As explained in Chapter 3, this represents a shift from ad-hoc and unproven procedures to consistent, repeatable, and recognized processes. All of the states participating in this study have adopted PMI standards, which were described as a useful generic blueprint for EVM use in individual states implementing the practice. However, a key theme that emerged in the interviews in discussing industry standards was that one size does not fit all.

The component of tailoring of EVM procedures to fit project context was described by 12 of 17 respondents as very important, with an average rating of 3.75 out of 5. Interview participants spoke of tailoring in terms of project characteristics and type. As projects become more costly and risky, more intensive procedures are typically applied, such as extensive performance baseline reviews at major project gates and detailed monthly reporting. In contrast, smaller projects with relatively low risk may only require reporting on an exception basis if CPI and SPI thresholds are broken. For example, Georgia's Critical Project Review Panel requires monthly status for major projects. However, SPI is used to trigger variance reporting on an exception basis for smaller projects with less risk, helping the EPMO focus attention on major risks and avoid costly implementation of unnecessary EVM. For project type, several officers described how they have modified EVM systems to better align with agile approaches. For example, in Kentucky, the EPMO plans to work with agencies in the future to develop flexible versions of EVM compatible with specific agile approaches, such as Scrum. This was explained to be very important for both the acceptance of EVM and its effective use.

On independent reviews of performance baselines, nine of 16 respondents indicated that these were very important, with an average rating of 3.5 out of 5. Several interview participants explained how these helped establish mutual understanding of risks among project stakeholders and identify issues early. In some states, these reviews occur throughout execution, at major gates of the project. As the case study of New Mexico described, the EPMO conducts assessments of "agency readiness" at major gates. In some cases, these reviews enable the EPMO and agency to proactively manage risks and mitigate them before they materialize. For example, it has helped pinpoint key human resource gaps on projects, enabling the EPMO to

secure the needed expertise from other agencies or external consultants. In addition, these reviews occasionally lead to revisions in cost and schedule baselines of a more realistic nature.

Nine of 16 respondents indicated it was very important to develop corrective action plans based on EVM indicators, with an average score of 3.5 out of 5. As the Nebraska officer explained, a direct linkage between EVM indicators and corrective action plans provides needed clarity of responsibilities, by making clear the metrics that must be used, specifying thresholds that require plans, and how these plans should be developed and presented to the EPMO. Regarding statewide projects the EPMO is responsible for delivering, the officer attributed some of their success to simple and disciplined corrective action procedures. However, Nebraska is a decentralized state where agencies are not required to follow EPMO guidelines. As a result, some agencies do not exhibit the same level of discipline in taking corrective action based on EVM indicators, limiting their ability to meet their cost and schedule objectives.

Human Capital. Regarding EVM training programs, nine of 16 respondents indicated they were very important for effective use of EVM, with an average rating of 3.63 out of 5. Notably, none of the states interviewed had their own EVM training programs; instead it was typically conducted as part of Project Management Professional (PMP) certifications, other continuing education, and on-the-job training. When asked about training initiatives, a few officers noted the need for the development of core skills, such as scheduling, before prioritizing EVM training; this aligns with the case of Alabama. An officer from Tennessee commented, “If implemented and supported by leadership, PMOs can effectively establish the disciplines and guidelines required for projects to use EVM practices. PMOs should also be prepared to create effective training programs.”

Only four of 16 respondents rated certified PMPs as extremely or very important, giving it the lowest average rating for the factors affecting implementation, 2.81 out of 5. The frequency tabulation in Table 4.3 shows the wide range of perceptions on this factor and the concentration at the midpoint of the range. The follow-up interviews were mostly with participants who felt certified PMPs were moderately important. In the early 2000s, Virginia created the "Project Manager Selection and Training Standard," establishing minimum qualifications and training standards for all project managers. Overall, the results have been positive in implementing PMI practices. However, a few officers explained that successful EVM is truly a team effort; PMPs simply cannot do it alone. For that reason, EVM training programs for non PMPs, such as engineers and budget analysts, are considered to be relatively more important. Moreover, EVM is certainly not beyond the comprehension of project managers who are not PMP-certified.

Concerning contractor experience with EVM, only two of 16 respondents indicated this was extremely or very important, giving it the second lowest average rating for the factors affecting implementation, 3.0 out of 5. As the frequency tabulation shows, most respondents indicated such experience to be moderately important. In Kansas, reforms were implemented that required contractors to comply with EVM reporting requirements. Given the relatively high proportion of work that is contracted out on IT projects, and the dollars at risk, this was considered critical in gaining control of projects in entirety. Over time, this has led to better control of and communication with contractors, providing the visibility needed to quickly identify issues and adjust. An officer from Kansas noted that:

> Because Kansas requires all reportable projects to follow the Kansas methodology, all projects and vendors must abide by those requirements. This gives the agencies a set of guidelines in which to manage the project, as well as the vendor. Our requirement of

quarterly reporting for all reportable projects helps the agencies and vendors work together to manage the project deliverables and keep project status data up to date.

In sum, these results highlight the importance of several factors for successful EVM implementation. In establishing centralized offices, it is critical for the EPMO to move beyond oversight and become a trusted partner in capacity building. In developing policy, the adoption of industry standards is a key first step. However, tailoring of procedures to fit with project context is very important for successful use of EVM in IT project management. Finally, conduct of performance baseline reviews and development of corrective action plans based on EVM indicators help catch problems early and allow for adjustments.

Discussion

As the role of technology in government has grown, the need for effective project management in the public sector has taken on increasing importance. State governments are now in the permanent business of IT project management, investing in a costly and diverse mix of projects across agencies and governmentwide. Therefore, development of robust EPM strategies in state government is critical to avoid the notorious "ticking time bombs" of IT project management, specifically, project failures, cost-overruns, and schedule delays (Bloch, Blumberg, & Laartz, 2012; Flyvbjerg, 2017; Standish Group, 2015). Policymakers need research that provides evidence on the effectiveness of management strategies and how to execute them in their operating environments.

This research finds EVM to be an effective EPM strategy, providing several key contributions to IT project management, as reported by the officers in this study. These contributions include early warning of cost overruns and schedule delays, facilitation of corrective action, and more consistently meeting performance objectives. However, officers

indicate several factors are critical to realizing these benefits, such as the establishment of an EPMO, tailoring of industry standards to fit project context, training programs, linking corrective action plans to EVM indicators, and conducting independent reviews of performance baselines. In fact, these findings align closely with the EVM body of knowledge.

Regarding contributions to project management, EVM as an effective early warning system for cost overruns and schedule delays is consistent with previous research using both perceptual (Kim et al., 2003; Song, 2010) and archival data (Batselier & Vanhoucke, 2015; Christensen & Heise, 1993; Christensen & Payne, 1992; Fleming & Koppelman, 2010; Willems & Vanhoucke, 2015). Results showing that EVM helps facilitate corrective action are consistent with GAO studies of U.S. federal agencies (U.S. Government Accountability Office, 1997, 2009a). Finally, findings showing that EVM helps meet schedule and cost targets align with prior survey research on the achievement of performance objectives (Song, 2010). Therefore, with 17 state EPMOs reporting similar benefits of EVM application, evidence in support of its use for major state IT projects is compelling, or at least suggests the need for additional research,.

However, ultimately realizing these benefits requires a carefully designed implementation strategy led by the EPMO. As the case study of Alabama illustrates, the strategy cannot simply be “guns blazing,” in which EVM requirements are imposed statewide without regard to agency maturity. Instead, there are benefits to taking a gradual approach, piloting EVM on projects with experienced managers. Over time, it is important for EVM to be applied consistently, which means that agencies cannot be given broad discretion in determining when to use it. Concerning factors affecting implementation, the importance of adopting industry standards, tailoring procedures to fit project context, conducting independent reviews of performance baselines, providing training, and developing corrective action plans based on EVM indicators align with

findings from GAO studies of U.S. federal agencies (U.S. Government Accountability Office, 2009a, 2009b, 2012, 2015, 2016, 2019).

The adoption of industry standards, the move from ad hoc and unproven procedures to consistent, repeatable, and recognized practices, represented a key initial step taken by EPMOs in reforming IT project management in state agencies. However, to make EVM effective in IT project management, several states have taken steps to tailor standard procedures to better align with agile approaches. For example, as noted above, Kentucky plans to work with agencies in the future to develop flexible versions of EVM compatible with agile. This was described as critical for the acceptance of EVM, and ultimately, its effective use. This is an important point. Specifically, while leaner PMI standards can provide effective EVM policy for public sector use, such standards need to be tailored to realize the benefits of EVM in IT project management in state government.

Regarding corrective action plans, a direct linkage between EVM indicators and the requirements for such plans gives needed clarity of responsibilities—specifically, in making clear the metrics that must be used, specifying thresholds that require plans, and how these plans should be developed. Concerning statewide projects the Nebraska EPMO is directly responsible for, the officer attributed some success to simple and disciplined corrective action procedures. However, as a decentralized state, the EPMO in Nebraska does not enforce EVM requirements, limiting its ability to intervene based on such indicators. Simply put, without a requirement for corrective action plans based on EVM indicators, policy is weak because it does not ensure that metrics are used to adjust or hold agencies accountable for such adjustments.

Of the factors affecting implementation, training emerges as one of the most important. Each of the case studies demonstrated the need for EVM training. As explained in Chapter 3, the

literature provides overwhelming evidence pointing to the need for training to realize the intended benefits of EVM (Kim et al., 2003; Song, 2010; U.S. Government Accountability Office, 2008, 2009a, 2012, 2016, 2019). Yet, at present, none of the states in this study have formal EVM training requirements. In the U.S. federal government, GAO found that enforcement of training requirements has been more effective in securing the needed skills than simply offering training programs (U.S. Government Accountability Office, 2009a, 2019). Therefore, state governments may benefit from incorporating EVM into their training and consulting services. However, as the case of Alabama demonstrated, some state agencies may need to establish core competencies, such as scheduling, prior to EVM training.

The case study of Georgia provides perhaps the most intriguing findings, specifically the use of GEMS in getting input from a wide range of stakeholders. As described, GEMS does more than report EVM metrics and accompany them with variance reporting from the project manager. For example, on time metrics, GEMS surveys engineers to capture their perceptions on the extent to which they agree that 1) milestones have been completed, 2) near term schedule objectives are realistic, and 3) the project can be delivered on its planned date. Georgia's experience has shown that including these perspectives provides a more complete understanding of project status, occasionally providing early warning that EVM reported solely by the project manager would not reveal. The officer considered this a significant change to manage, since project managers are accustomed to controlling the reporting of project status. However, it is ultimately a collaborative process that respects project team members by engaging them and recognizing their valuable perspectives.

Conclusion

Results from the research above provide several key discoveries for project management and public management and policy. For project management, this original research on EVM implementation, which regards subnational governments, found that EVM provides multiple contributions to enterprise IT project management in U.S. state governments, such as early warning of cost overruns and schedule delays, opportunity for corrective action and mitigation of risk, and helping meet cost and schedule performance objectives. However, ultimately realizing these benefits requires an implementation strategy involving the establishment of a centralized project management office, comprehensive and clear policy, reporting tools, and training. These findings align closely with the EVM body of knowledge, especially GAO studies of its application by U.S. federal agencies.

In the realm of public management and policy, this work contributes to performance management, public budgeting and financial management, and policy implementation. Regarding performance management, this study indicates that EVM can serve as an effective management tool in state government for major IT projects. This research contributes to capital budgeting by explaining how IT project delivery in state government can be improved with use of EVM. Concerning policy implementation, this study is important for demonstrating that specific and comprehensive EVM guidance promotes consistent execution of process across state agencies, and that a gradual approach to implementation is sound. Finally, the participatory evaluative approach applied in Georgia demonstrates how soliciting input from project team members can provide good information (early warning) that left to just project managers alone might not surface. Given the sheer cost of IT in state government and its growing role in service

delivery, these findings are important for state policymakers and public managers responsible for delivering such projects on time and on budget.

Future research can improve on some of the limitations of this study. To increase the relatively low number of participants, scholars could survey additional EVM users, such as agencies responsible for major health care IT systems, in states that currently use EVM. To address and correct for the subjective nature of the perceptual measures, research using archival data could use the same dimensions of performance as dependent variables and factors affecting implementation as independent variables. More will be written on future research in the concluding chapter.

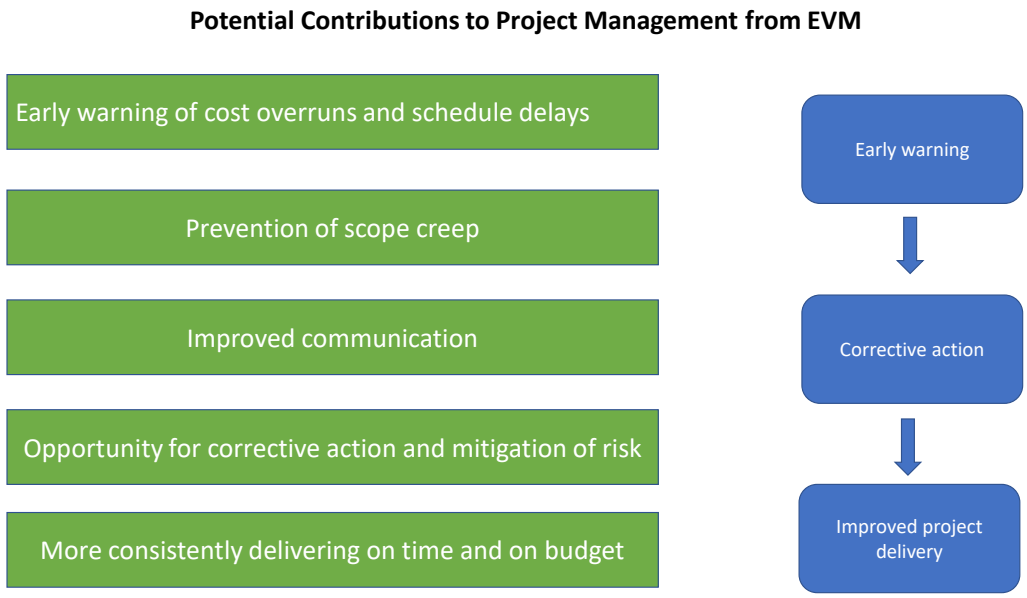


FIGURE 4.1: Potential Contributions to Project Management from EVM

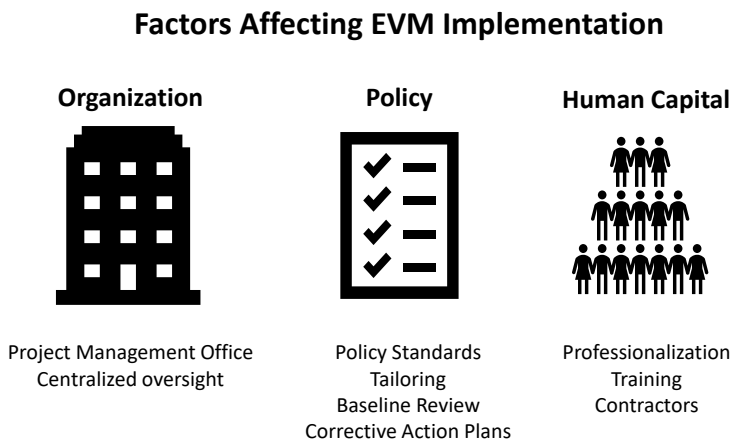


FIGURE 4.2: Factors Affecting EVM Implementation

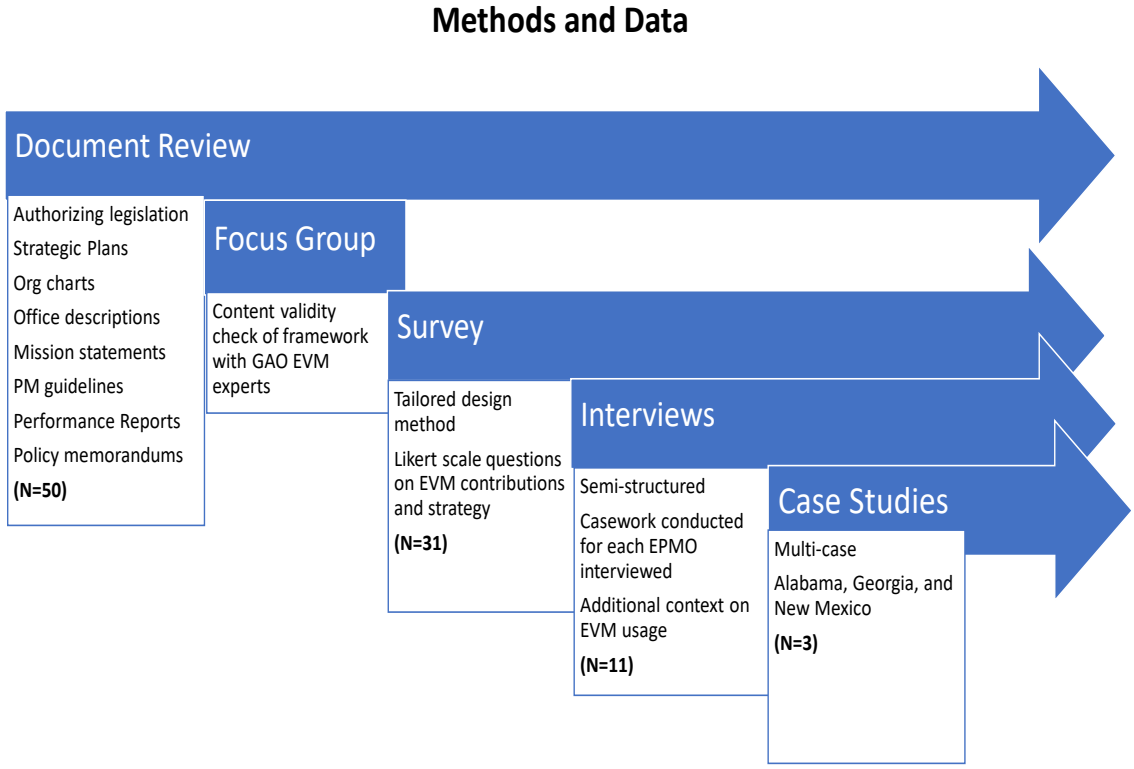


FIGURE 4.3: Research Methods and Data

Based on your experiences in state government managing IT projects, indicate your perception regarding potential contributions to project management from EVM:

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
EVM is an effective early warning system for cost overruns	○	○	○	○	○
EVM is an effective early warning system for schedule delays	○	○	○	○	○
EVM helps prevent scope creep	○	○	○	○	○
EVM helps achieve cost objectives	○	○	○	○	○
EVM helps achieve schedule objectives	○	○	○	○	○
EVM indicators are effective in communicating project status in portfolio management	○	○	○	○	○
EVM helps facilitate corrective action	○	○	○	○	○
Overall, EVM is an effective performance management tool	○	○	○	○	○

FIGURE 4.4: Likert Questions, Contributions to Project Management from EVM

Based on your experiences in state government managing IT projects, indicate your perception of the potential importance of the following factors to successful EVM implementation.

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Establishment of a centralized project management office	○	○	○	○	○
Adoption of EVM industry standards	○	○	○	○	○
Tailoring of EVM procedures for project context	○	○	○	○	○
Project Management Professionals (PMP)	○	○	○	○	○
EVM training programs	○	○	○	○	○
Contractor experience with EVM	○	○	○	○	○
Independent reviews of the performance baseline	○	○	○	○	○
Development of corrective action plans based on EVM indicators	○	○	○	○	○

FIGURE 4.5: Likert Questions, Factors Affecting Implementation

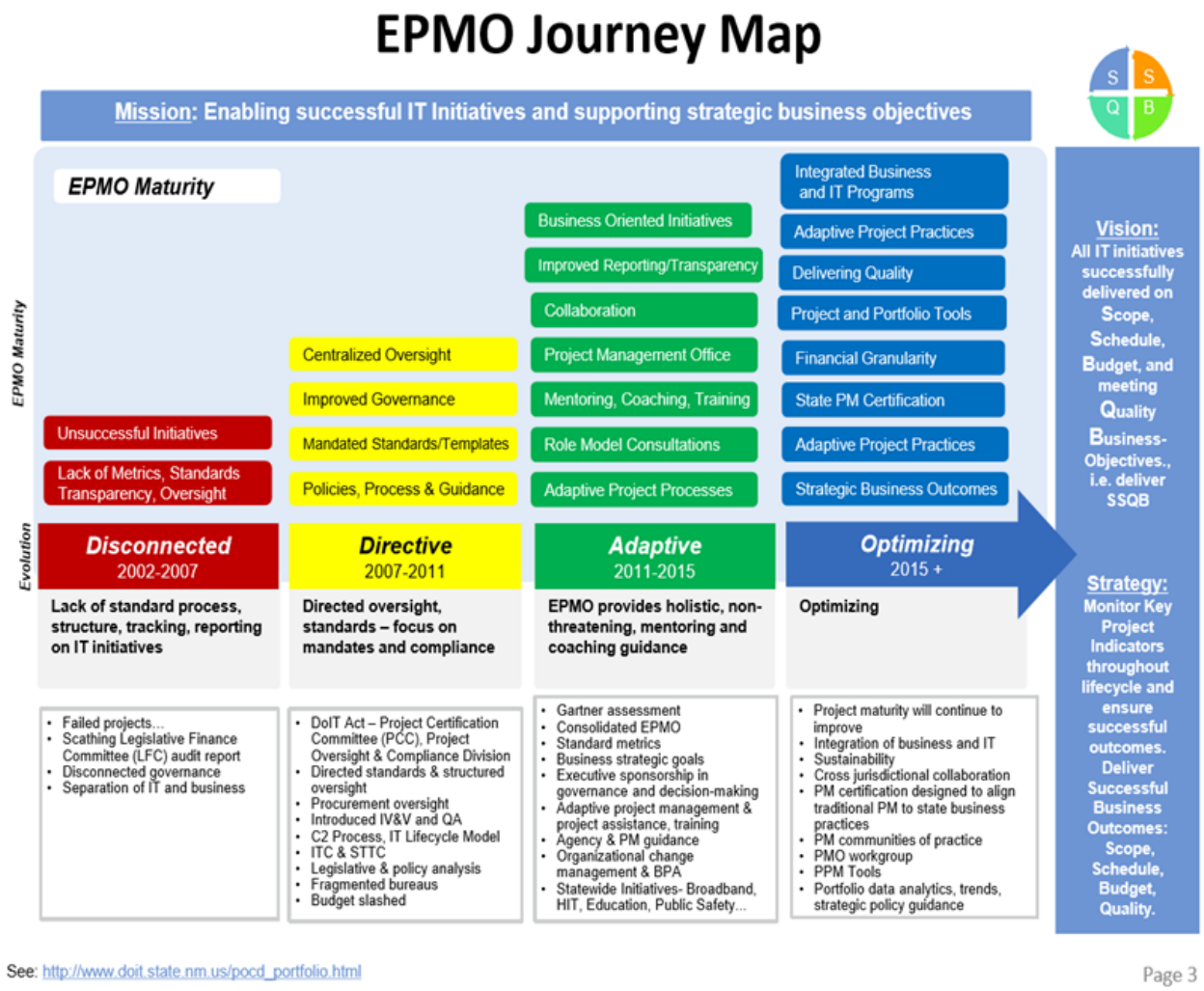
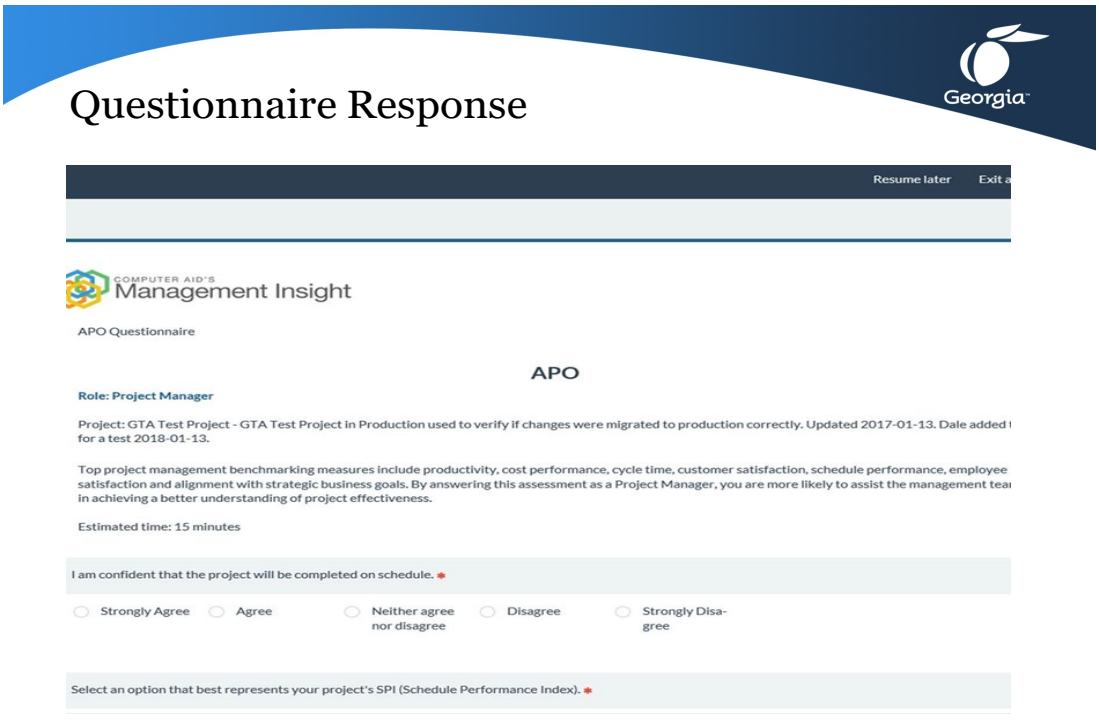


FIGURE 4.6: New Mexico EPMO Journey Map



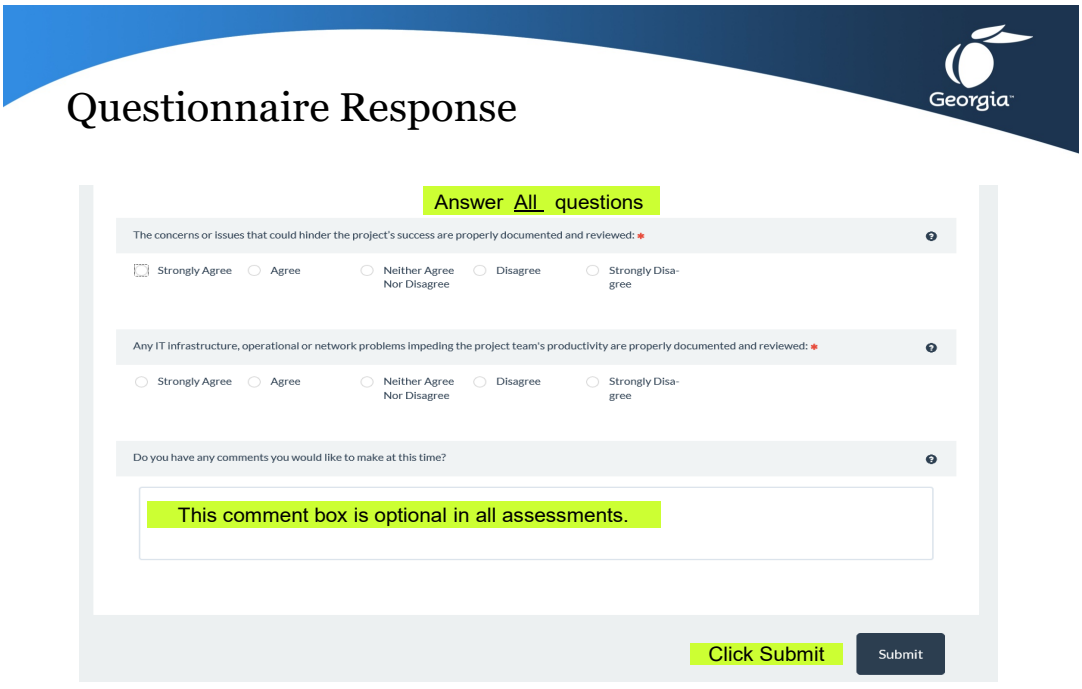


FIGURE 4.7: Sample Questions from GEMS

TABLE 4.1: Frequency Tabulation, EVM Contributions to Project Management (EVM users, N=17)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
EVM is an effective early warning system for cost overruns			5	**8**	4
EVM is an effective early warning system for schedule delays		2	1	**12**	2
EVM helps prevent scope creep		5	**5**	7	
EVM indicators are effective in communicating project status in portfolio		1	3	**10**	3
EVM helps facilitate corrective action		1	3	**11**	2
EVM helps achieve cost objectives			4	**13**	
EVM helps achieve schedule objectives		1	1	**14**	1
Overall, EVM is an effective performance management tool			2	**13**	2

TABLE 4.2: Descriptive Statistics for EVM Contributions to Project Management (EVM Users, N=17)

Contribution to Project Management	Mean	Standard Deviation	Minimum	Median	Maximum
Early Warning, Cost Overruns	3.94	0.75	3	4	5
Early Warning, Schedule Delays	3.82	0.81	2	4	5
Prevention of Scope Creep	3.12	0.86	2	3	4
Communication, Portfolio Management	3.88	0.78	2	4	5
Facilitation of Corrective Action	3.82	0.73	2	4	5
Achievement of cost objectives	3.76	0.44	3	4	4
Achievement of schedule objectives	3.88	0.60	2	4	5
Overall	4.00	0.50	3	4	5

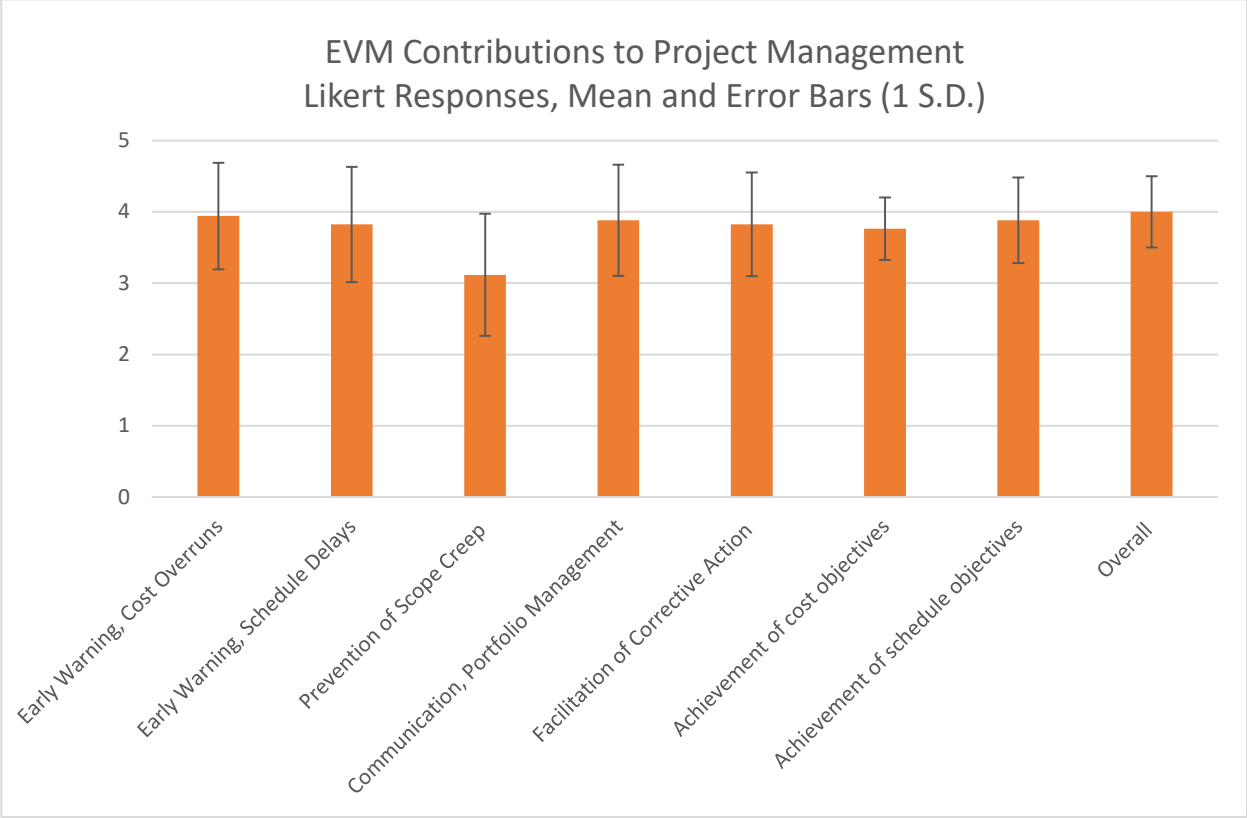


FIGURE 4.8: EVM Contributions to Project Management (EVM users, N=17)

TABLE 4.3: Frequency Tabulation, Factors Affecting EVM Implementation (EVM users, N=16)

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Establishment of a centralized project management office			7	**6**	3
Adoption of EVM industry standards		2	6	**7**	1
Tailoring of EVM procedures for project context		1	3	**11**	1
Independent reviews of the performance baseline		1	6	**9**	
Development of corrective action plans based on EVM indicators		1	6	**9**	
Project Management Professionals (PMP)	3	4	**5**	1	3
EVM training programs		1	6	**7**	2
Contractor experience with EVM		3	**11**	1	1

TABLE 4.4: Descriptive Statistics for Factors Affecting EVM Implementation (EVM Users, N=16)

Factor Affecting Implementation	**Mean**	**Standard Deviation**	**Minimum**	**Median**	**Maximum**
Centralized PMO	3.75	0.77	3	4	5
Industry Standards	3.44	0.81	2	4	5
Tailoring	3.75	0.68	2	4	5
Independent Baseline Review	3.50	0.63	2	4	4
Corrective Action Plans	3.50	0.63	2	4	4
PMP	2.81	1.38	1	3	5
Training Programs	3.63	0.81	2	4	5
Contractor experience	3.00	0.73	2	3	5

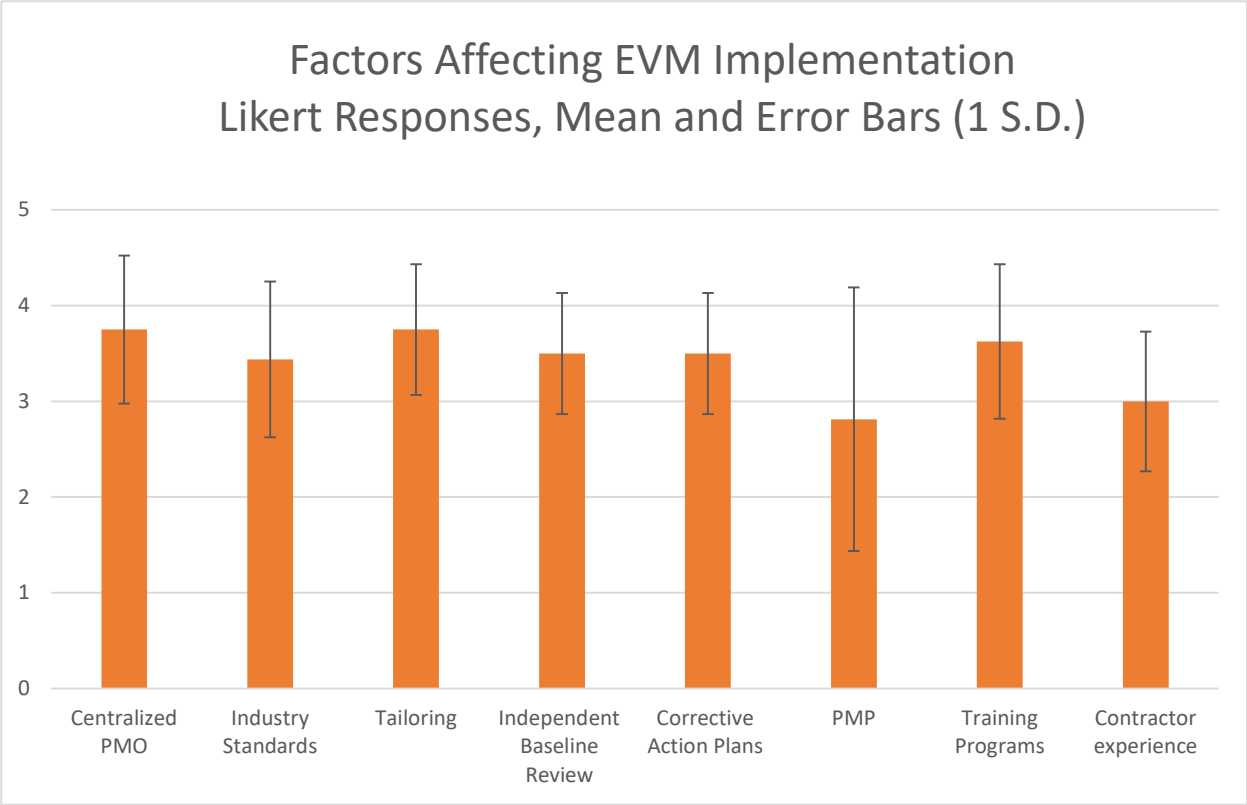


FIGURE 4.9: Factors Affecting EVM Implementation (EVM users, N=16)

CHAPTER 5

EARNED VALUE MANAGEMENT IN STATE DEPARTMENTS OF TRANSPORTATION

State Departments of Transportation (DoTs) face pressure from elected officials, the public, and media to improve project delivery for practically all modes of transportation (National Cooperative Highway Research Program, 2009). If transportation projects are not delivered on time and within budget, possible impacts range from local disruption and inconvenience to more wide-ranging safety, economic, and budgetary effects. These budgetary impacts are significant: transportation accounts for the largest category of capital expenditures for state governments, comprising 64% of all capital expenditures and totaling $73 billion in Fiscal Year 2019 (National Association of State Budget Officers, 2019). Therefore, development of project management strategies is needed to effectively control and manage costly transportation projects.

This chapter examines the adoption and implementation of EVM in state DoTs as a strategy to improve capital project delivery. In doing this, it answers the three primary research questions of this dissertation for state transportation projects: have state DoTs adopted EVM as part of their project management strategy? If so, what are the results of implementing EVM for major state transportation projects? What factors are critical to effective conduct of EVM by state DoTs? The research design utilized here is the same employed in Chapters 3 and 4, involving document review, implementation of electronic surveys and telephone interviews, and multiple case studies. Collectively, this provides primary data on the operations and policies of

state DoTs regarding capital project management, perceptual measures of EVM contributions and the relative importance of strategic elements for realizing intended benefits, and explanatory context on the origin and evolution of EVM in state DoTs.

Results from 34 states DoTs found that most have established statewide transportation PMOs, adopted industry standards, and defined their project management guidelines. However, in roughly half of the states, project teams are not required to adhere to statewide PMO guidelines. Six state DoTs currently use EVM, four have plans for adoption in the near future, and 24 have no plans for EVM adoption or use in the near future.

The six states that currently use EVM are Arizona, California, Maryland, Nevada, North Carolina, and Washington. Officers from these states provided their perceptions of its contributions to transportation project management and conditions that promote effective use. Most indicated that EVM has provided early warning of cost overruns and schedule delays, improved communication, facilitated corrective action, and assisted in meeting cost and schedule performance objectives. Respondents claimed that the establishment of centralized project management offices, adoption of Project Management Institute standards, independent reviews of performance baselines, development of corrective action plans based on EVM indicators, reporting tools, and training programs all support productive application of the project management strategy. These results align with the general EVM body of knowledge, studies of its use in the U.S. federal government, and findings presented earlier in this research related to IT project management application by U.S. state governments.

This chapter most adequately addresses the first primary research question of the dissertation, regarding adoption. However, because only six state DoTs report use of EVM,

findings here should be considered preliminary. Still, the case of North Carolina provides a strong case for applying EVM to transportation projects by state governments.

The chapter flows from explanation of a top-down strategic framework for EVM in state DoTs, adjusting the framework presented earlier for IT projects onto transportation projects. The next section explains the research methods and data used to analyze EVM use by state DoTs, again, the same as those used in Chapters 3 and 4. Next, case studies of three state DoTs are presented to provide context on the origin and evolution of EVM application by the agencies. Following this, results are provided in three parts: strategic framework applicability, contributions to project management, and factors affecting use for state government transportation projects. The chapter concludes by relating these findings to the EVM and public management literatures and discussing the implications for policymakers and public managers.

Strategic Framework

Given that transportation projects comprise almost two-thirds of total capital expenditures in U.S. state governments, the ability of state DoTs to consistently meet their cost objectives has significant consequences for state budgeting. Without skillful planning and disciplined execution, costly transportation projects requiring several years to complete can easily generate major cost overruns (American Association of State Highway and Transportation Officials, 2007; National Cooperative Highway Research Program, 2009). However, even with strong planning and execution, transportation projects are exposed to risks outside state agency controls. For example, unexpected sub-surface conditions, utility problems, and environmental and permitting concerns are frequently blamed for costly overruns and prolonged schedule delays related to these types of projects (American Association of State Highway and Transportation Officials, 2007). A study conducted by the American Association of State Highway and

Transportation Officials (AASHTO) found that for state transportation projects greater than $5 million, 30% experienced cost overruns of 10% or more, and only 35% were delivered on schedule (American Association of State Highway and Transportation Officials, 2007).[20]

Therefore, effective project management strategies are critical to the success of state DoTs, as well as the general fiscal health of states. These strategies must support multi-modal transportation systems that move people and goods by surface, air, and water. In addition to challenges related to project delivery and traditional budget competition among state agencies, state DoTs must also grapple with competing demands for scarce funding among districts across the state. Thus, in establishing their governance structures, state DoTs can form a statewide Project Management Office (PMO) to help prioritize transportation investments and conduct oversight of project delivery. Because most transportation projects are delivered by DoT regional district offices, strategies must also account for the need to establish consistency in project delivery across districts.

It is also important for state governments to be proactive and comprehensive in developing their transportation project management strategies. Though they receive significant federal funds, state DoTs are given considerable discretion in managing transportation projects. For example, the U.S. DoT simply requests an explanation of how progress will be tracked rather than requiring a specific methodology for in-progress evaluation (United States Department of Transportation, 2017). In the case of transportation-related projects, these project management guidelines have been combined with construction standards (United States Department of Transportation, 2016). Although EVM is a recommended practice, the combined construction and project management standards are so voluminous that many state DoTs are understandably

[20] This was a study of 26,500 state transportation projects in 20 state DoTs, delivered from 2000-2005.

unfamiliar with their full extent. Finally, AASHTO has prioritized the development of design and construction standards over project management guidelines.[21] Therefore, because PMI standards are clear and comprehensive, state DoTs should utilize these instead of relying strictly on guidance from the U.S. DoT or AASHTO.

The top-down strategic framework for state DoT EVM implementation, presented in Figure 5.1, is a modified version of that presented in Chapter 3. The first element of the framework regards the strategy involved for the establishment of a statewide PMO for transportation projects, responsible for strategic alignment, human capital, and policy and practice guidance. Regarding strategic alignment, the PMO can assist in prioritizing transportation projects by providing analysis of expected impacts to congestion, safety, and economic growth. For human capital, the PMO can ensure that the DoT has the necessary skills to successfully manage projects by providing training, consulting, and avenues to professionalization for responsible parties.

Concerning policy and practice guidance, the PMO is generally given authority to establish industry standards and define project management guidelines. To ensure consistent application of guidelines across state regional districts, project teams are required to follow these directives, with the PMO conducting central oversight. The most important of these guidelines is the directive that EVM is required practice for major transportation projects. This can be achieved by specifying clear criteria for the application of EVM, by designating cost, contract type, duration, and risk as factors to consider in determining when to use EVM on projects.

[21] Interview with AASHTO member, February 18, 2020.

Finally, EVM should be tailored according to project context. For example, this may involve modifications based on project type and/or cost, risk, and/or other factors.

Methods and Data

The research methods and data for state DoT use of EVM are presented in Figure 5.2. The research design involves document review, conduct of a focus group, implementation of electronic surveys and telephone interviews, and development of case studies. The first stage of the document review, which occurred throughout the study, was a preliminary sweep of state DoTs project management policies. Completion of a comprehensive literature review followed, before the development of an initial strategic framework. To assess the content validity of the framework, the author conducted a day-long focus group with top EVM experts at U.S. GAO headquarters. As a point of clarification, while the focus group discussed use of EVM for large-scale Information Technology (IT) and transportation projects in state government, the elements of the framework are generalizable across project types. The GAO analysts agreed that the elements of the framework constituted a comprehensive strategy and gave feedback on refining properties of certain elements.

After consideration by GAO, subsequent document review performed analysis of state DoT project management guidelines to assess their consistency with industry best practices, as specified in the framework. At the summary level, this analysis found that most state DoTs had adopted a blend of policy standards from the Project Management Institute (PMI), United States Department of Transportation (US DoT), and AASHTO. However, state DoT project management guidelines rarely specified use of EVM. Therefore, just as it was for IT, the transportation framework was delimited regarding details for planning, scheduling, cost-

estimation, and baseline review. Instead, it focused on more fundamental elements, such as whether project teams must follow PMO guidelines and the application of EVM.

An electronic survey, a replication of the one used for state EPMOs, was designed to collect primary data from state DoTs on their PMOs, project management guidelines, and the application of EVM. The state DoT document review informed survey development as well. For example, the document review helped specify the types of PMOs that a DoT may have, such as statewide, regional, and across different types of transportation projects. A member of AASHTO's Technical Committee on Project Management (TCPM) volunteered to pilot the survey. The member reported having a clear understanding of all questions, completing it in less than 30 minutes. The survey instrument is provided in Appendix C.

The tailored design method was used in constructing and implementing the survey (Dillman, Smyth, & Christian, 2014). As explained in Chapter 3, the tailored design method, like any surveying strategy, aims to reduce sources of error relating to coverage, sampling, nonresponse, and measurement. However, the method uniquely emphasizes the importance of social exchange and establishing trust with respondents, thereby incentivizing their response. In the new digital landscape of survey research, it is critical that researchers take steps to establish trust in asking for participation (Dillman et al., 2014). Therefore, letters were sent through the physical mail, using official University of Georgia envelopes and letterhead, notifying subjects they would be sent an electronic invitation to participate in the survey on a designated date. To further incentive response, the same strategy used for EPMOs was implemented for state DoTs. In exchange for participation, subjects were offered a copy of research findings and invited to attend a collaborative webinar to discuss study results and exchange lessons learned with other DoT project management experts.

The contact strategy began with an initial sweep of state DoTs; this yielded contact information for PMO officers in a dozen states. To better locate appropriate contacts in remaining state DoTs, the author contacted the AASHTO Technical Committee on Project Management (TCPM), a board with representatives from approximately 15 state DoTs, and was invited to give a brief overview of the research to members. Following this meeting, board members agreed to participate in the electronic survey, with some offering to contribute in the telephone interviews, too. The survey was first sent to members of the TCPM. Following their initial responses, letters were sent to state DoT PMO officers identified in the initial sweep who were not members of the TCPM. For any remaining states, letters were addressed to the Secretary of Transportation, noting that 15 states had already contributed to the study and that members of AASHTO had offered their expertise and planned on attending the webinar.

Each of the 50 states was contacted to participate in the study; a total of 34 states responded (see Figure 5.3). The participating state DoTs provided a rich set of implementation environments to examine, varying on demographic, economic, geographic, and political dimensions. Categorizing the states into five quintiles of ten based on population revealed that each quintile contained at least five of the responding states. As Figure 5.3 shows, participating states are also spread across various geographical regions of the country and represent a good mix of conservative and liberal political environments. Participants are experienced; twenty-two of 34 have at least 10 years of experience in state transportation project management. In addition, the majority have professional accreditation, as either certified Project Management Professionals (PMP) or Professional Engineers (PE).

To conduct a comparative analysis of state DoTs using the survey data, the author created an index using the same elements of the framework from Chapter 3. The index is comprised of

seven nominal variables including the existence of: statewide PMO, policy standards, guidelines, centralization, EVM, criteria for application, and tailoring. As Table 5.1 shows, a variable is coded 1 if the criterium exists and 0 if it does not. Scores can range from zero to seven. Thus, state DoTs that have adopted more comprehensive reforms score higher on the index. A state that has not adopted EVM can score no higher than four of seven. Just as in Chapter 3, the index is intended to provide a simple descriptive "state of the states" on the existence of framework components.

Regarding contributions to project management from EVM and factors affecting implementation, this chapter examines the same variables as Chapter 4 (see Figures 5.4 and 5.5). As Figures 5.6 and 5.7 show, the survey uses the same series of Likert scale questions to provide perceptual data. The question stems were adjusted to ensure that responses captured perceptions specific to transportation project management in state government. A five-point scale with labels indicated for each point on the scale provides sensitivity of measurement and comparability with previous EVM research. The ordinal responses are converted to numerical scores to conduct quantitative analysis of central tendency and dispersion.

Explanatory analysis concerning the impetus for the adoption of transportation project management reforms and results of EVM implementation is provided by a combination of document review, open-ended survey questions, follow-up semi-structured interviews, and case analysis. Semi-structured interviews with officials in eight state DoTs were completed, each lasting 30 minutes to an hour. The author conducted a thorough document review for the participating state DoT prior to each interview. Those interviewed were asked to provide context on the origin and evolution of the PMO in their agency, similar context on EVM adoption and implementation, and future plans for EVM.

The final component of this research design engaged case study analysis of three state DoTs. Each case chronicled the origin and evolution of project management reforms in the chosen state, EVM adoption and implementation, and future plans for EVM. Consideration of cases was limited to those state DoTs that participated in telephone interviews. Just as in Chapter 4, the data collected from the document reviews and interviews in each DoT provided decisive data. The judgment sample of cases included California, North Carolina, and Texas. Each of these states provided comprehensive documents and substantial interview data, and supported development of a chronological account of EVM use by the transportation agency. In the next section, the introductory paragraph for each case explains what lessons were gathered from that particular transportation agency experience.

Case Studies

California

California scored 6 out of 7 on the strategic framework, missing only the component of tailoring of EVM practices to fit project context. California DoT (Caltrans) utilizes PMI best practices and project teams are required to follow these guidelines. EVM is currently used for various projects but is not required for major transportation projects. Nonetheless, Caltrans plans on adopting formal EVM requirements sometime in the future, with requirements that will be "across the board." More generally, Caltrans has been effective in achieving cost savings through innovative project delivery, as will be described below. This case of California is important for demonstrating potential innovations other state DoTs can consider to achieve cost savings, conduct of EVM prior to formal PMO directives, and preconditions for effective use of EVM.

Caltrans has a statewide PMO with 12 regional divisions, each with their own project management unit. The statewide PMO was created over 20 years ago, in response to the need to

"get a better handle on capital dollars" in the early 1990s, an officer noted. In the three most recent fiscal years, capital expenditures for transportation projects have exceeded $4 billion.[22] Therefore, effective transportation project management, critical for avoiding impactful cost overruns, has been a recent area of focus for the state's legislature. For example, the Road Repair and Accountability Act of 2017 (SB 1) requires Caltrans to identify at least $100 million annually in cost savings. In striving to realize these savings, Caltrans has been innovative in more efficiently delivering transportation projects.

Caltrans exceeded the $100 million target set by the act in the first year, with significant savings from streamlining environmental review ($41.5 million), accelerating work ($64 million), and value analysis studies ($49 million).[23] Regarding streamlining environmental review, Caltrans is the first state DoT to form an agreement with the Federal Highway Administration (FHWA) to perform National Environmental Policy Act (NEPA) reviews. By taking responsibility for these reviews, Caltrans expedites preparation of necessary environmental documents, allowing projects to begin construction sooner than would otherwise be the case.[24] As an officer explained, because of their sheer volume of projects, even reducing project schedules by one month on average is significant from a portfolio perspective. On the acceleration of work, the passage of SB 1 included $1.5 billion in funding to move up construction schedules of projects to avoid cost escalation. Finally, value analysis studies have

[22] National Association of State Budget Officers. 2019 State Expenditure Report.
[23] Caltrans, SB1 Annual Efficiencies Report 2018-2019: https://dot.ca.gov/-/media/dot-media/programs/sb1/documents/sb1-annual-efficiencies-report-2018-19-final.pdf
[24] Per the SB 1 Annual Efficiency Report: "NEPA Assignment streamlines the federal environmental review and approval process by eliminating FHWA project-specific review and approval. NEPA Assignment does not alter federal environmental protection standards. California assumes sole responsibility and liability for its NEPA decisions and is required to waive its right to sovereign immunity against NEPA related actions brought in federal court." https://dot.ca.gov/-/media/dot-media/programs/sb1/documents/sb1-annual-efficiencies-report-2018-19-final.pdf

been conducted on projects greater than $50 million, with one of the objectives being to reduce the total cost of transportation projects by modifying their design.[25]

Regarding policy and practice guidance, Caltrans PMO developed their project management guidelines using PMI, AASHTO, and FHWA standards. Project teams must follow PMO guidelines when managing their projects. Still, Caltrans struggles with consistent application of project management guidelines statewide. At the same time, the agency takes steps to avoid the negative consequences of a one-size-fits-all strategy, working with districts and managers to tailor project management strategies according to project context.

EVM is currently used by Caltrans, but not on the majority of projects and not as a required practice agency-wide. An officer from the state noted that several "savvy" project managers have been able to use it effectively to achieve cost and schedule performance objectives. Caltrans has plans to adopt EVM requirements for statewide application in the future. When asked about factors that contributed to this decision, an officer said that "maturity in project management practices have allowed for a better understanding of the benefits EVM may provide." [26] For implementation, the objective is to have EVM practiced "across the board" within a few years. Given that EVM is already in use for some projects, has realized some success, and Caltrans' high level of project management maturity, the agency is relatively well-positioned for statewide EVM implementation for transportation projects.

In discussing factors critical to forthcoming implementation of EVM, an officer stressed the importance of data quality. In their experience, this can be decisive in realizing the intended

[25] From SB 1 Annual Efficiency Report: "Value Analysis methodology is optimized through refining the design to increase performance and/or decrease costs, analyzing lifecycle costs, user benefits and overall return on investment." https://dot.ca.gov/-/media/dot-media/programs/sb1/documents/sb1-annual-efficiencies-report-2018-19-final.pdf

[26] This is from the electronic survey.

benefits of the practice. At the most basic level, reporting tools must have the capacity to integrate scope, schedule, and cost data to ease implementation and provide reliable real-time metrics. Factors cited by this official as extremely important to successful EVM implementation included tailoring of procedures to align with project context and training programs. Given the numerous, diverse, and costly set of transportation projects spread across the state, flexible strategies and the availability of skills to effectively implement the tool will be key to realizing benefits from EVM.

In sum, the case of Caltrans is important for illustrating how innovative approaches to transportation project management, such as streamlining environmental review and conducting value analysis studies to meet the cost savings objectives of SB1, can result in significant cost savings for state governments. It also points to preconditions for effective conduct of EVM in state DoTs, such as project management maturity and reporting tools capable of integrating scope, schedule, and cost data to ensure that timely and reliable metrics are generated.

North Carolina

North Carolina DoT (NC DoT) scored a 6 out of 7 on the strategic framework. Like California, the only component missing was tailoring of EVM practices to align with project context. In contrast to California, EVM is currently required for major transportation projects in North Carolina; at present, it is used on the majority of transportation projects. Of the states interviewed, North Carolina emerged as the most advanced user of EVM for these types of projects. Of the six state DoTs that indicated using EVM, North Carolina provided the best evidence that EVM implementation by state DoTs offers benefits.

NC DoT has a statewide PMO, created over 20 years ago, and 14 regional divisions. In contrast to most state DoTs, the responsibilities of the PMO are not limited to project delivery

but also involve strategic investment prioritization. In 2013, the state passed the Strategic Transportation Investment Law (STI Law) to provide a holistic statewide view of transportation needs and promote data-driven decision making. The state is actually implementing its fifth generation of strategic prioritization. The current process, "P 5.0," provides priority rankings for transportation projects, based on a wide range of criteria relating to potential economic, fiscal, safety, mobility, and environmental impacts.

PMI standards were adopted around 2005 to help comprehensively define project delivery practices from "A-Z." Project teams must follow PMO project management guidelines in managing their projects. Officers from the state described efforts, concurrent with the adoption of PMI standards, to migrate from a disparate set of project management tools to an integrated project management system (SAP) that eased implementation of PMI practices statewide, including EVM. Recently, NC DoT has implemented process improvements accelerating project delivery. For example, in the past year, NC DoT accelerated delivery of 350 transportation projects.[27] Officers from the state noted that, in many instances, such acceleration could be attributed to streamlining environmental review. To be clear, officers noted this did not involve cutting any corners or sacrificing environmental objectives.

EVM was adopted following PMI standards and is currently used on the majority of the state's transportation projects. In developing their EVM policy, the PMO referenced federal EVM guidelines in establishing clear criteria for application, linking EVM indicators with corrective action plans, and defining criteria for baseline revision. The PMO provides criteria to project teams to determine when to use EVM, based on cost, duration, risk, and contract type. When asked about the initial rollout of EVM, an officer explained that it was relatively smooth,

[27] State of North Carolina. 2020. "Build NC." North Carolina Department of Transportation, Budget and Finance. Accessible at: https://www.ncdot.gov/about-us/how-we-operate/finance-budget/Pages/build-nc.aspx

because of the integrated SAP system and experienced project managers. Regarding contributions to project management, EVM has enabled project managers to catch problems early, with pinpoint precision, and adjust to meet schedule and cost objectives. Also, PMO review of project milestones prior to releasing funds effectively flags potential problems before projects begin. Finally, archival analysis of their EVM data has allowed them to identify components of projects most likely to experience delays, and to plan for these risks in advance.[28]

NC DoT targets that 90% of construction projects be delivered on schedule. They met their targets in the last two years, with 93% and 91% of construction projects delivered on time.[29] NC DoT's target for total budget overruns is less than 5%, which was also achieved in the last two years, with total budget overruns of -0.3% and 1.9%. On their successful project delivery, officers noted several factors crucial to achieving these time and cost objectives, including commitment to excellence from the secretary, talented personnel across NC DoT, reporting tools, EVM, risk management, and knowledge exchanges (officers regularly visit regional divisions to trade lessons learned and explain new policies). There are no major changes planned to EVM at this time. NC DoT will continue its disciplined approach to EVM application statewide.

The case of NC DoT illustrates how state DoT project management can support both project delivery and investment prioritization, as documented in previous chapters for IT project management. Moreover, it shows that EVM can serve as an effective performance management tool for state transportation projects. Factors described as critical for success in project delivery

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[28] Recall from Chapter 2 that EVM uses a WBS to organize work, etc. In this case, they used the WBS to identify the components, such as environmental review, that could be delayed, ultimately leading to escalation of construction costs.

[29] North Carolina Department of Transportation. 2019. *Annual Performance Report*. Accessible at: https://www.ncdot.gov/about-us/our-mission/Documents/2019-annual-report-interactive-fullscreen.pdf

align with the EVM body of knowledge, especially the presence of strong reporting tools for ease of implementation. In sum, state DoTs seeking clearer and more comprehensive information about their enormous capital expenditures have much to learn from NC DoT and its use of EVM for transportation projects.

Texas

Texas scored 3 out of 7 on the strategic framework, missing the strategic elements of centralization and all EVM components. In Texas, project management is decentralized; regional districts are given broad discretion in managing their projects. While the state reported no current usage of EVM, it has plans to adopt EVM as a policy recommendation for major transportation projects and use it in the near future. The case of Texas provides an example of EVM considered for adoption to support a strategic initiative to improve timeliness of project delivery.

Texas DoT has a statewide PMO, established in 2012, and 25 regional districts. An officer pointed to two primary factors contributing to the formation of the statewide PMO: to increase transparency and to streamline project management systems by developing an integrated portfolio and project management system. In describing legacy systems, the Texas DoT 2015-2019 Strategic Plan noted that "current portfolio and project management processes and technologies are fragmented and nonstandard."[30] Accordingly, the Modernize Portfolio and Project Management (MPPM) initiative implemented new systems to "improve TxDOT's ability to track and report project status, control project management processes, and collaborate across the agency's business units."[31] One of the goals of the MPPM was to continue to gain trust among stakeholders by successfully delivering transportation projects on time.

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[30] Texas DoT Strategic Plan (2015-2019), p. 48. Accessible at: https://ftp.dot.state.tx.us/pub/txdot-info/sla/strategic-plan-2015-2019.pdf

[31] Texas DoT Strategic Plan (2015-2019), p. 48. Accessible at: https://ftp.dot.state.tx.us/pub/txdot-info/sla/strategic-plan-2015-2019.pdf

Concurrent with the formation of the statewide PMO, project management guidelines were defined using PMI, AASHTO, and US DoT standards. In addition to these industry sources, Texas DoT utilized policy and practice guidance from other state DoTs, such as Virginia and Florida. Regarding the application of PMO guidelines, project teams can choose to use them but have the option of developing and using their own practices in managing their local transportation projects. Given the sheer number of costly, complex, and diverse transportation projects spread across the vast and populous state of Texas, the PMO faces challenges in establishing consistent application of guidelines statewide. At the same time, the office strives to align practices with project context and focus training where it is needed, based on maturity. When asked about strategies implemented to achieve these objectives, an officer noted that collaborative meetings are regularly held with representatives from regional districts to exchange lessons learned and focus on developing a holistic set of set of project management skills through training, mentoring, and leadership development.

In Fiscal Year 2018, transportation capital expenditures totaled $5.5 billion.[32] In the General Appropriations Act, the state legislature establishes performance targets for project delivery, and results are reported to the Texas Legislative Budget Board. In Fiscal Year 2019, Texas DoT completed 91% of design projects on time, exceeding their target of 81%.[33] The target for percentage of construction projects completed on budget was 85%. Results were close to the target, at 78%. The target for percentage of construction projects delivered on schedule was 65%. Essentially, this target was met, with 64% of such projects completed on schedule. Texas DoT will begin to implement EVM to improve project delivery.

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[32] National Association of State Budget Officers. 2019. State Expenditure Report. Accessible at: https://www.nasbo.org/mainsite/reports-data/state-expenditure-report

[33] Texas Department of Transportation. 2020. “Performance Results Summary.” Accessible at: https://www.txdot.gov/inside-txdot/division/state-affairs/performance-results.html

An officer responded in the survey that EVM was being adopted to "proactively manage on time project delivery."[34] Currently, EVM is not used and plans for implementation are being worked out. When asked about these plans, an officer noted that they would first focus on time metrics. The focus on time metrics aligns with one of the main goals of the MPPM, to continue to build trust among project stakeholders by consistently delivering transportation projects on schedule. Specifically, use of EVM is hoped to contribute to an increase in the percentage of construction projects delivered according to planned schedules. The officer continued that forthcoming EVM will be relatively lean and not too intensive. With respect to factors important to upcoming EVM implementation, the officer noted the need to educate project managers on its potential contributions to project management.

In sum, the case of Texas provides a recent example of EVM adopted to support a strategic initiative to improve the timeliness of project delivery. The implementation of EVM will be challenged, given new protocols and its prescribed conduct within a decentralized environment. On the other hand, the magnitude of transportation capital expenditures in the state suggests that forthcoming application of EVM has the potential to provide significant cost savings.

Results

This section provides results in three parts: strategic framework, contributions to project management, and factors affecting implementation. Each part begins by providing summary analysis and then discusses findings for individual components.

[34] From electronic survey.

Strategic Framework

Figure 5.8 provides summary results for the 34 participating state DoTs. Findings indicate that most states have established statewide PMOs, adopted industry standards, and have defined their project management guidelines. However, in 18 of 34 state DOTs, project teams are not required to follow PMO guidelines. Regarding EVM, six states are current users and most define criteria for EVM application, but none describe their current EVM strategy as tailoring practices according to project context. Table 5.2 provides a detailed breakdown of scores by state, showing an average score of 3.2 (standard deviation of 1.3). A snapshot of the results by state is also provided using a map chart. In Figure 5.9, states with higher scores are presented in deeper shades of blue.

Figure 5.8 shows that 22 state DoTs have established a statewide PMO. Figure 9 indicates that most were created between 2000 and 2020; however, several existed prior to 2000.[35] Of the DoTs with statewide PMOs, a few also have regional PMOs, similar to California. Notably, ten DoTs reported they had yet to establish any PMOs, meaning they do not have a statewide office, district offices, or offices for different types of transportation projects. The main impetuses for establishing statewide PMOs involved the sheer cost of transportation projects and their share of total capital expenditures in state government, the need to comprehensively define practices, and the practice of splitting out project management from engineering.

On transportation capital expenditures, each of the officers interviewed from eight DoTs cited the desire to manage capital expenditures more efficiently for the establishment of their statewide PMO. In California, for instance, PMO creation bubbled up from efforts to improve the efficiency of project delivery, with a centralized office beginning in the early 1990s and

[35] The number of PMOs listed in Figure 5.8 differ from Figure 5.9 because two respondents were not sure when their statewide PMO was formed.

current initiatives focusing on achieving significant cost savings stipulated in state law. Statewide PMOs have also provided stakeholders a portfolio level view of transportation projects. For example, in Texas, the Modernize Portfolio and Project Management (MPPM) initiative aggregates data from 25 regional districts for portfolio analysis. With the exception of North Carolina and Virginia, none of the state DoTs interviewed cited central clearance of budget requests as one of the reasons for creating a PMO. In this regard, transportation project management reforms have been focused more on budget execution than preparation.

Although each of the eight officers cited the desire to improve capital project management, none referenced large-scale project failures or the frequency and magnitude of cost overruns, which surfaced in Chapter 3 for IT projects. Instead, the focus was on the considerable dollars spent and significant potential savings from more consistently delivering projects on budget. Concerning the distribution of cost overruns, a few officers explained that overruns of 10% were typical. However, because the cost of mega transportation projects often exceeds $500 million, overruns of even 10% present tremendous financial risks.

Regarding the need to comprehensively define project management practices, a few interview participants explained that their DoT had some form of guidelines prior to the establishment of the PMO. However, they did not fully encapsulate industry practices. For instance, in North Carolina, PMI standards were adopted to define practices from “A to Z.” Similarly, an executive from Georgia described the need to outline practices from “cradle to grave.” The need to split out project management from engineering resulted from acknowledgement of project management as a profession; engineers showed relatively little interest in becoming professionalized in this regard. In a few state DoTs, this led to the recruitment and hiring of certified Project Management Professionals (PMPs) to improve project

management and leadership, relieving engineers of duties outside their wheelhouse that competed for their valuable time.

State DoTs have also taken steps to improve project delivery by having the PMO provide training and consulting services to project teams. Figure 5.11 provides a breakdown of the types of consulting services provided. A few officers explained the importance of documenting and sharing lessons across regional districts to aid in knowledge dissemination. In both Texas and North Carolina, officers described regular meetings with district managers to share lessons learned, document them, and consider how they can be used to inform the development of new procedures and/or provide illustrations of the importance of adhering to such procedures.

Although many state DOTs have yet to establish a statewide PMO, the vast majority of them have adopted industry standards and defined project management guidelines based on them. Specifically, Figure 5.8 indicates that 30 state DoTs have adopted industry standards and 29 have defined their project management guidelines accordingly. Figure 5.12 provides a breakdown of PMO sources of practice guidance; AASHTO standards were most frequently cited, with 26 state DoTs using these to develop their project management guidelines. Other industry standards referenced include the U.S. DOT and PMI, both cited by 18 state DoTs. North Carolina's adoption of PMI was critical for defining practices from "A to Z," including EVM. Although AASHTO and U.S. DoT standards cover a wide range of practices, they do not cover and explicate the universe of practices evidenced by PMI as fully. Regarding EVM, PMI standards are most explicit in identifying it as a best practice.[36] Thus, as will be considered in the discussion, the nature of policy standards may impact likelihood of EVM adoption.

[36] US DoT EVM policy is clearly defined for federal IT projects and various types of Federal Aviation Administration (FAA) acquisitions that support the National Airspace System. However, as explained in the strategic framework, U.S. DoT has issued a vague set of protocols for state transportation projects, providing state DoTs considerable discretion in drafting their own guidelines, even for projects funded by federal dollars.

Regarding centralization, Figure 5.13 shows that in 16 of 34 state DoTs, project teams are required to follow guidelines issued by the statewide PMO. In speaking with officers, a few noted the difficulty of establishing consistent application of project management guidelines across regional districts. For example, in Texas, there are 25 regional districts, with vastly different populations, transportation needs, and levels of project management maturity. In addition, project teams are given discretion in determining whether to follow PMO guidelines, and many smaller districts lack their own PMOs. An officer from the state explained that the combination of the high number of districts, variation among them, and the discretion they are given in managing projects introduces challenges to achieving consistency in project delivery statewide. In contrast, California's 12 regional districts must follow guidelines issued by the statewide PMO, and each has their own PMO. Thus, in comparison to Texas, California has a more centralized approach to transportation project management.

Figure 5.14 shows that six state DoTs currently use EVM, four have plans for usage in the near future, and the remaining 24 have no formal plans for EVM adoption or usage in the near future. The six states that currently use EVM are Arizona, California, Nevada, North Carolina, Maryland, and Washington. States planning on using EVM for major transportation projects in the near future are Colorado, Missouri, Texas, and Virginia.

North Carolina adopted EVM following its establishment of PMI standards. Washington DoT adopted EVM as part of a series of reforms to improve project delivery in 2005, though the current application is decentralized and relatively infrequent. In some cases, its use is limited to that of a contracting tool, specifically in helping to determine progress payments to contractors. Concerning future adopters, use of EVM in California DoT is already widespread but not

formally required. Because the case studies of California, North Carolina, and Texas provide details on these states, this section briefly highlights adoption in Virginia.

In Virginia DoT, there are plans to recommend EVM for all major projects within the next few years. Like Texas, Virginia said it had a desire to manage project delivery more "proactively." In reflecting on the challenges that lie ahead with statewide EVM, an officer from Virginia explained that, in their experience, managing the change itself was going to be critical, specifically demonstrating the value of EVM for transportation projects, getting acceptance from project managers, providing training, and reporting tools that eased the burden of implementation. The officer provided these specific remarks on a change such as EVM:

> Proactive, portfolio-wide improvements require prompt and reliable schedule and budget data be readily available, along with the administrative and hierarchical structure to handle and implement wide-spread changes. And all this assumes there is the leadership will and skill to change, and the staff expertise to plan, organize, and implement the improvements. It has been our experience that changing the culture can be far more challenging than designing a process or program advancement.

As Figure 5.8 shows, four state DoTs provide criteria for determining when to use EVM. Specifically, they cite dollar amounts, contract types, project durations, and risk levels as factors they consider when deciding when to use EVM. As the case study of North Carolina DoT explained, use of EVM is widespread and done for the purposes of project and portfolio management. In Washington DoT, EVM is less widespread and utilized as a project and contract management tool, without EVM portfolio metrics statewide. Maryland DoT has formally adopted EVM within the last five years and it is currently used, but not on the majority of

projects. Finally, each state DOT's current EVM strategy is developing a common set of procedures for use across projects.

Contributions to Project Management

Table 5.3 provides a frequency tabulation for officers responding to the survey from the six states that currently use EVM, with the median response indicated in bold. With the exception of preventing scope creep, most participants "agree" that EVM provides several contributions to transportation project management in state government. Table 5.4 gives measures of central tendency and dispersion for each of these potential contributions. The visualization in Figure 5.15 graphs the mean and plots an error bar that is plus or minus one standard deviation from the mean. This part of the section now provides analysis of results for individual components.

Early Warning and Scope Creep. Regarding early warning of cost overruns, five of six respondents either agreed or strongly agreed that EVM is an effective early warning system for such performance issues, with an average rating of 4.17 out of 5. On early warning of schedule delays, five of the six officers agreed or strongly agreed that EVM was effective in that regard, with an average rating of 4.0 out of 5. In speaking with executives about early warning of performance issues, interviews followed the cadence from Chapter 4, focusing on understanding two general uses of the data: variance analysis of performance to date and forecasting.

In short, usage in this regard aligns with findings from Chapter 4: EVM metrics are used throughout project execution for analysis of performance to date. Specifically, measurement timeliness and the ability to pinpoint the component of the project at variance is considered effective. However, because many state DoTs have established risk-based cost estimation procedures that utilize historical data from similar projects in developing financial forecasts,

EVM metrics are only one of many techniques utilized. Here too, their use in forecasting total projects costs is discouraged until projects reach 20% complete or stabilize.

An officer from Maryland DoT explained that EVM has provided all levels of management (both project managers and statewide portfolio managers) with early visibility into cost- and time-related problems. Reflecting on their experience with EVM, an executive from Maryland DoT explained that finding budget risks earlier rather than later has helped them reduce cost overruns, effecting to millions in savings. In addition, EVM indicators have helped them manage schedule risks proactively, assisting in avoiding major delays. Specifically, the Maryland officer explained that:

> Finding budget or financial risks earlier provides huge savings on cost and schedule overruns. All 800+ Contract Managers go through EVM training as part of an overall Contract Management Training curriculum. Through this training we have identified millions in savings and cost avoidance.

Concerning the ability of EVM to prevent scope creep, only two of six officers agreed or strongly agreed that EVM was effective in this capacity, with an average rating of 3.17 out of 5. As in Chapter 4, most respondents did not consider EVM to be a scope management tool, and used other contracting approaches to manage the scope of work.

Communication and Corrective Action. Each of the six officers agreed or strongly agreed that EVM indicators were effective in communicating project status in portfolio management, with an average rating of 4.33 out of 5. Because state DoTs take on a tremendous number of costly projects spread across their state, the statewide PMO needs a common set of metrics to continuously monitor and evaluate project status, identify projects most at risk for not meeting their cost and schedule targets, and intervene based on the metrics. In the North Carolina

DoT, disciplined use of EVM across the state has enabled the PMO to continuously track all projects with reliable and timely indicators, evaluate corrective action plans, and determine appropriate interventions. Future plans for other state DOTs, such as California, Virginia, and Texas, involve plans to use EVM indicators in portfolio reporting to better track project status statewide. On the importance of portfolio reporting and use of EVM indicators in communicating project status, an officer from California commented that:

> Consistent portfolio status reporting allows for project managers to "check-in" and report on progress and performance against their budgets. Data tools and dashboards which show how projects are performing against schedules and budgets in real time are bringing better engagement to overall project delivery, not just project management. Breaking the project into smaller logical phases, while budgeting and allocating those phases separately has seemed to improve the overall budget performance and improved change management.

Concerning EVM's ability to facilitate corrective action, five of six officers agreed or strongly agreed that EVM was effective in this regard, with an average rating of 4.0 out of 5. The examples provided in this section for Maryland and North Carolina show how EVM can facilitate corrective action as both a project and portfolio management tool. Therefore, attention is given here to the discovery of EVM as a contract management tool in a couple of state DoTs. As officials from Nevada and Washington DoTs explained, they use EVM, in some cases, to determine progress payments for contractors. This facilitates corrective action for the following reason: if contractors do not earn value as specified in the project baseline, they do not get paid. When asked how this was distinct from previous contracting approaches, it was noted that EVM

provided a recognized PMI best practice for establishing project milestones and determining progress payments based on work performed to date.

Achievement of Performance Objectives. On the achievement of performance objectives, respondents gave favorable ratings for EVM's ability to help realize both cost and schedule targets. All six officers either agreed or strongly agreed that EVM assisted in attaining cost objectives, with an average rating of 4.17 out of 5. On schedule objectives, five of six officers agreed that EVM aided in realizing these, with an average rating of 4.0 out of 5. As the case study of North Carolina DoT illustrates, some of their success in project delivery is attributed to the consistent and disciplined application of EVM statewide. In Fiscal Years 2018 and 2019, total cost overruns for major transportation projects delivered were less than 2% of the total planned capital expenditures.[37]

As noted earlier, Maryland DoT reported that EVM has improved project and portfolio management because of its early warning capabilities. In their experience, EVM has helped improve their ability to proactively manage risks and take corrective action, where possible. Importantly, as quoted from the Maryland officer earlier, much of this success can be attributed to human capital strategies that build EVM capacity within the DoT and among their contractors. In Nevada, the DoT official explained that, in their estimation, 90% of the value of EVM ends up coming from 10% of projects. For this reason, use of EVM is currently limited to very costly projects where even relatively small changes (less than 5 percent) can result in large cost overruns.

Overall. Overall, five of six officers either agreed or strongly agreed that EVM was an effective performance management tool, with an average rating of 4.17 out of 5. As Table 5.3

[37] North Carolina Department of Transportation. 2020. "DOT REPORT Program." Accessible at: https://www.ncdot.gov/about-us/our-mission/Performance/Pages/ncdot-report-program.aspx

shows, with the exception of preventing scope creep, most respondents agreed that EVM provides several contributions to transportation project management in state government. Thus, the favorable overall rating is reflective of EVM's ability to provide early warning of cost overruns and schedule delays, facilitate corrective action, and help achieve performance objectives.

Factors Affecting Implementation

Table 5.5 provides a frequency tabulation for the six respondents indicating current use of EVM, with the median indicated in bold.[38] Findings indicate that the factors are typically described as moderately or very important for successful implementation of EVM on state transportation projects. Table 5.6 gives measures of central tendency and dispersion for each of these factors. The visualization provided in Figure 5.16 graphs the mean and plots an error bar that is plus or minus one standard deviation from the mean. Individual components are examined below.

Organization. Three of six respondents indicated that the establishment of a centralized project management office was very or extremely important for successful implementation of EVM, with an average rating of 3.67 out of 5. As a few officers noted, given the vast number of costly projects spread across regional districts, the PMO was important for effectively managing the state's portfolio of transportation projects and improving project delivery statewide. For example, in Washington's DoT, prior to reforms, they did not know the number of active projects statewide nor the percentage of projects that met their cost and schedule targets at delivery, let alone real time status when executed. An officer from Washington explained that, without a central office, the DoT was unable to aggregate performance data from regional

[38] The median is not bolded where it does not correspond directly to an ordinal response category. Please see Table 5.5 for these median values.

districts and help them proactively manage risks. Leadership from the central office during this time, referred to as the "Doug era,"[39] was critical in creating policy standards and defining project management guidelines to improve project delivery, specifically proactively managing risk with EVM.

Policy. Concerning the adoption of EVM industry standards, two of six respondents reported this as very or extremely important, with an average rating of 3.17 out of 5 (standard deviation 1.17). As in the strategic framework, U.S. DoT and AASHTO have prioritized the development of design and construction standards over project management guidelines. As such, PMI standards were described as important for North Carolina DoT because they provided a basis to define practices from "A to Z," one of them being EVM. In this regard, PMI standards have been important in filling gaps in state transportation project management guidelines. For tailoring of EVM practices to fit project context, two of the six respondents indicated this to be very or extremely important, with an average rating of 3.33 out of 5. As reported in the strategic framework, none of the state DoTs describe their current EVM strategy as tailoring to fit project context. Two officers noted that it was important for their statewide PMO to focus on consistent use of simple metrics statewide based on their current needs.

Four of six officers reported the independent reviews of performance baselines to be very or extremely important, with an average rating of 4.0 out of 5. A few officers noted general advantages of conducting these reviews, such as establishing a mutual understanding of risks among project stakeholders, acknowledging these risks in estimating total project costs and durations, and proactively mitigating risks. As the case study of North Carolina DoT explained, these reviews have been key to that state's success in project delivery—in particular, ensuring

[39] Referring to then Secretary of Transportation in Washington State Douglas MacDonald, and the sweeping set of reforms attempted during this time.

that cost and schedule objectives are not overly aggressive and reflect potential risks. In addition to establishing realistic objectives, these reviews ease use of EVM: if performance baselines are overly aggressive and objectives are not met, a meaningful measure of variance is not available until corrective action is taken to reset the baseline. Since one of the main purposes of EVM at the PMO level is to direct management attention to tractable problems in project delivery, it is critical to avoid wasted action by setting realistic baselines upfront.

On the development of corrective action plans based on EVM indicators, four of six respondents noted these to be very or extremely important, for an average rating of 3.67 out of 5. For this factor, examples from Maryland and North Carolina are used to illustrate the importance of linking EVM indicators to corrective action plans for project and portfolio management. In addition, use of EVM as a contracting tool in Nevada and Washington for determining progress payments was discussed as a strategy to ensure cash outflows correspond to value delivered.

Human Capital. Only two of the six respondents indicated that certified PMPs were extremely or very important, with an average rating of 3.5 out of 5. The other four respondents rated them to be moderately important. On this factor, a few officers noted a need to recognize project management as a profession, split out project management from engineering, and recruit and hire certified PMPs. Regarding the current adoption of EVM in Texas DoT, they recognize the need for project managers to successfully lead and simplify the transition to EVM.

Three of six officers rated EVM training programs as very or extremely important, for an average rating of 3.67 out of 5. The best illustration of this was provided by Maryland DoT, which attributed some of their success with EVM to their robust training programs. Requiring contract personnel to partake in EVM training helped them identify financial risks earlier, resulting in millions in cost savings and avoidance. Finally, concerning contractor experience,

three of six EVM users rated this to be extremely or very important, with a mean score of 3.4 out of 5. As a couple of officers explained, given the high proportion of capital expenditures that contractors are responsible for, it is important that contractors are capable of providing real time measures of output and cost data. If not, this limits the DoT's ability to track progress of individual projects and conduct portfolio analysis statewide.

Discussion

Previous research explained that there are two principal reasons for a new government program or policy: internal determinants and diffusion (Berry & Berry, 1990, 2018). This study found several internal determinants that contributed to the establishment of statewide DoT PMOs, their adoption of industry standards, and centralized application of project management guidelines, as specified in the strategic framework. Factors contributing to these reforms include the sheer magnitude of transportation capital expenditures, the desire to improve project delivery, and the need for comprehensive policy.

Since transportation capital expenditures account for almost two-thirds of total capital expenditures in state government, the ability to consistently deliver transportation projects on budget is critical. As in California, efforts to better manage capital projects through a centralized office are relatively long-standing. Central offices have also been important for providing stakeholders with a portfolio level view of transportation projects, as in North Carolina. Current efforts in Texas and California underscore the need for systems capable of providing a statewide view that ease the burden of data integration.

With the exception of North Carolina and Virginia, none of the respondents interviewed noted central clearance of budget requests as a reason for establishing their statewide PMO. Instead, reforms focused on improving project delivery. Thus, of the phases of the budgeting

process, state DoT reforms have dealt more with budget execution, audit, and evaluation than preparation and approval. Objectives to improve project delivery were not aimed at avoiding large scale project failures or persistent and devastating overruns, focusing instead on more consistently delivering projects on time and on budget.

Regarding the need for more comprehensive policy, many state DoTs had some form of project management guidelines prior to reforms. However, in many states, these guidelines emphasized design and construction standards and not project management guidelines. This can be partly attributed to weak policy standards, specifically those of US DoT and AASHTO. The federal government has commingled project management and construction guidelines and issued a vague set of protocols for state projects funded with federal money. In this respect, they have not provided a strong basis for states to define project management guidelines, nor has AASHTO. Again, the recently formed Technical Committee on Project Management (TCPM) hopes to strengthen guidance available to states for managing transportation projects. Given the lack of policy leadership from US DoT and AASHTO, several states turned to PMI because it is most comprehensive in defining project management practices.

State DoTs have mimicked each other in developing their project management guidelines, widely diffusing policy. Of the 34 state DOTs responding in this research, 20 reported using guidance from other states in defining their guidelines. Several officers explained in interviews how they used guidance from other state DoTs. For example, in Georgia, because transportation project management is centralized and the state population is relatively large, they sought out guidance from other centralized states with large populations. In developing their guidelines, Texas has pulled in experts from Virginia and Florida DoTs to help them craft their

new policies. Finally, the recently-formed AASHTO TCPM may serve as a platform for policy innovation and diffusion among state governments.

Six states currently use EVM, four will be using it soon, and the remaining 24 states have no formal plans for adoption or usage in the near future. Therefore, within the next few years, EVM will be practiced in some form in 10 of the 34 DoTs surveyed. As examples illustrate here, EVM has been adopted as part of implementing PMI standards, to improve project delivery by proactively managing time and cost risks. These results suggest that attention to PMI policy standards may increase the likelihood of EVM adoption. Of the 18 states that have adopted PMI policy standards, nine either currently use EVM or will soon. To put this in perspective, only 29% of state DoTs responding in this research will be using EVM in the near future. However, 50% of state DoTs that have adopted PMI policy standards will be using EVM in the near future.

Respondents from six state DoTs currently using EVM provided their perceptions of its contributions to project management and factors affecting implementation. Concerning contributions to project management, results indicate that EVM has served as an effective early warning system for cost overruns and schedule delays, helps communicate project status in portfolio management, facilitates corrective action, and assists in meeting cost and schedule objectives. Overall, five of the six officers either strongly agreed or agreed that EVM was an effective performance management system. These results align with the general EVM body of knowledge, studies of use in the U.S. federal government, and findings from this dissertation on IT project management in U.S. state governments.

For factors affecting implementation of EVM, respondents reported several factors to be very important in realizing the intended benefits of the practice. These include the establishment of centralized project management offices, adoption of PMI standards, independent reviews of

performance baselines, development of corrective action plans based on EVM indicators, reporting tools, project management maturity, and training programs. Here too, findings are consistent with established EVM literature and results from this dissertation on IT project management in U.S. state governments.

Of course, because these findings are based on the experiences of just six states, future research is needed to better understand the benefits of EVM implementation for state transportation projects and conditions for effective use. Nonetheless, results are encouraging. North Carolina provides a compelling case for statewide implementation of EVM. EVM policy diffusion into additional states will provide more evidence and likely interesting comparisons. For example, California and Texas are good candidates for comparative case analysis. As an officer from Texas explained, because 25 districts are given discretion in how they manage their projects, and several smaller districts do not have a PMO, it can be challenging to achieve consistency in project delivery statewide. In contrast, California has 12 regional districts that are required to follow guidelines issued by the statewide PMO, and each has their own PMO. Thus, study of EVM implementation in these states provides an opportunity to compare the experiences of states with large populations that vary on centralization strategies.

Conclusion

This chapter provides several discoveries to project management and public management and policy. For project management, it offers original research on transportation project management strategies and EVM adoption in U.S. state governments. This study, based on responses from 34 of the 50 states, finds that most have taken key initial steps in formulating strategy, such as creating centralized project management offices and developing policy based on industry standards. However, in roughly half of the states, project teams are not required to

adhere to statewide PMO guidelines. Regarding guidelines, PMI standards have been important for the development of comprehensive policy.

Officers from six state DoTs that currently use EVM provided their perceptions of its contributions to transportation project management and conditions that promote effective use. For contributions to project management, results indicate that EVM has provided users with early warning of cost overruns and schedule delays, improved communication, facilitated corrective action, and assisted in meeting cost and schedule performance objectives. Factors important for effective use include establishment of centralized project management offices, adoption of Project Management Institute standards, independent reviews of performance baselines, development of corrective action plans based on EVM indicators, reporting tools, and training programs. These results align with the general EVM body of knowledge, studies of use in the U.S. federal government, and findings from this dissertation on IT project management in U.S. state governments.

With respect to the three primary research questions of the dissertation, this chapter most adequately answered the first: have state DoTs incorporated EVM into their project management strategy? The research finds that six states currently use EVM and that four have plans for adoption in the near future. However, due to the limited number of DoTs that currently use EVM, this chapter provided weaker evidence for the other two research questions: what are the results of implementing EVM for major state transportation projects? What factors are critical for effective conduct of EVM on state transportation projects? The findings suggest there could be benefits of EVM application for state transportation projects. However, additional data is needed to better understand specific contributions of the practice and factors critical to effective implementation in this operating environment.

This research chronicled the origin and evolution of modern transportation project management reforms in U.S. state governments, thus contributing to public management practice. Factors contributing to the adoption of management reforms specified in the strategic framework included the sheer magnitude of transportation capital expenditures, the desire to proactively manage project delivery, and efforts to develop more comprehensive policy. Concerning policy implementation, this study is important for demonstrating that specific and comprehensive guidance promotes consistent execution of process.

Previous public budgeting and finance research has identified project management as an essential component of the capital budgeting process, to ensure that projects are delivered "on time and on budget." However, aside from noting potential advantages of centralized oversight, the field has been relatively silent on project governance and management strategies. Therefore, this empirical analysis of state DoTs provides a significant upgrade to our understanding of centralized project management and oversight. Given that transportation capital expenditures comprise almost two-thirds of capital expenditures in state government, these findings are important for state policymakers and public managers responsible for delivering these projects on time and on budget. In addition, they should be of interest to US DoT, which provides significant funding to state governments for transportation projects.

Future research can improve on the some of the limitations of this study. To address the relatively low number of respondents, scholars could survey additional EVM users in states that currently use EVM. Regarding the subjective nature of the perceptual measures, research using archival data could use the same dimensions of performance as dependent variables and factors affecting implementation as independent variables.

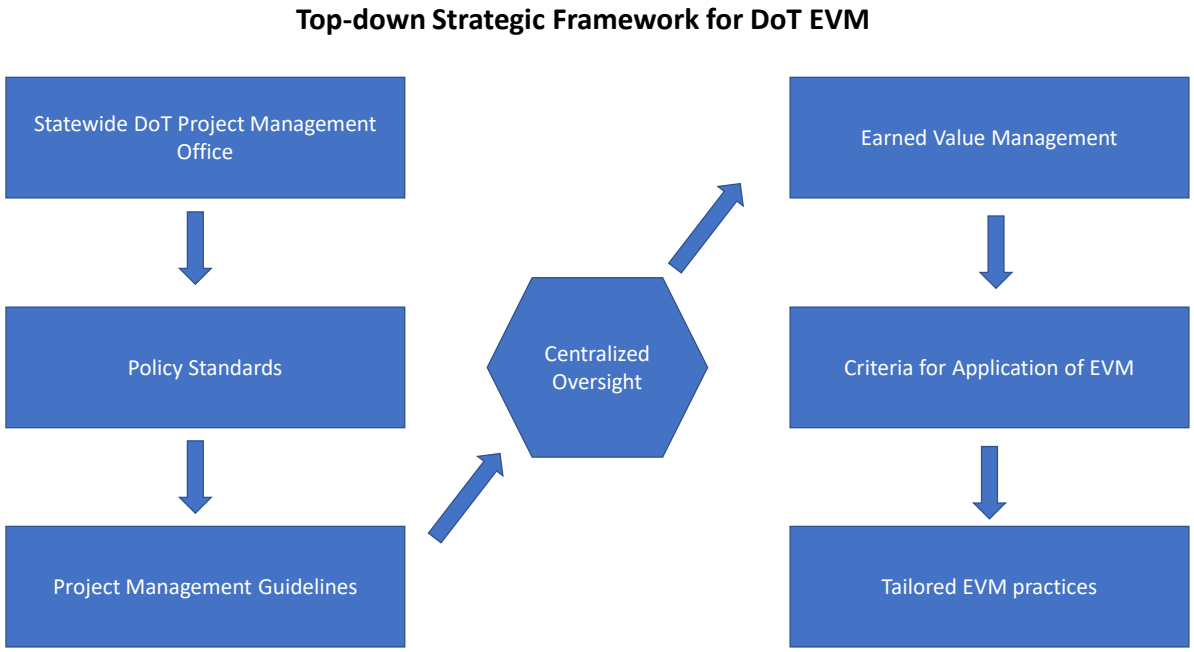

FIGURE 5.1: Top Down Strategic Framework

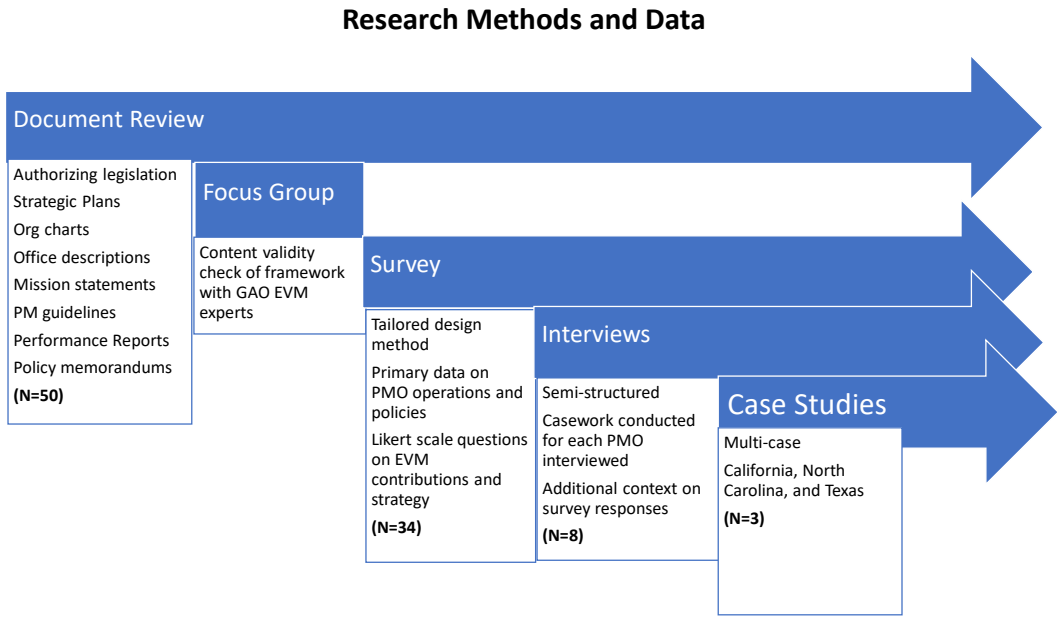

FIGURE 5.2: Research Design

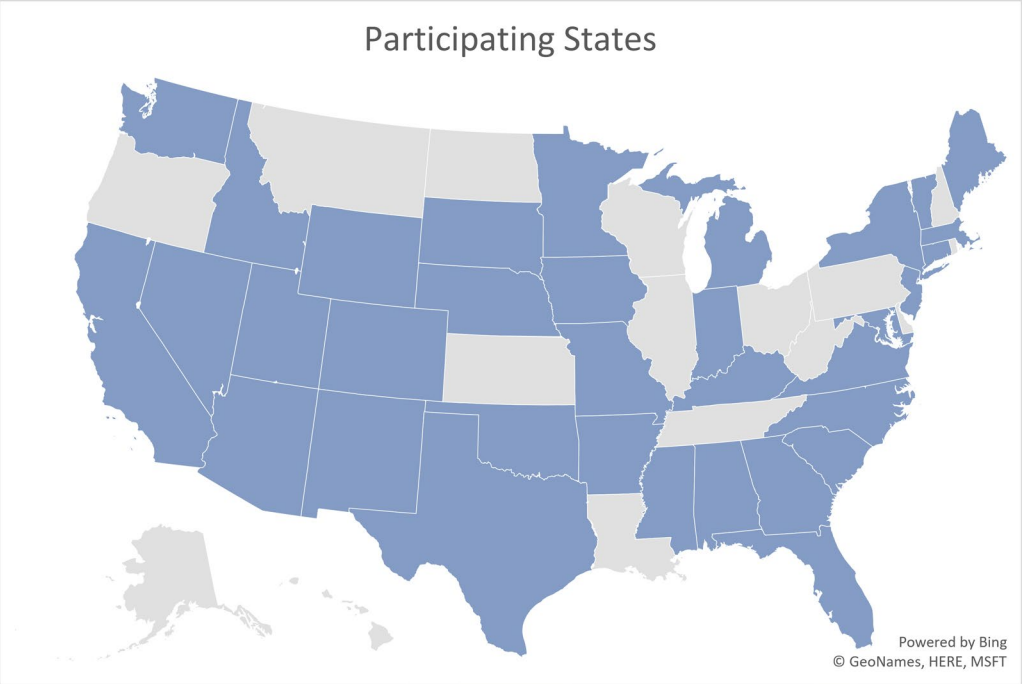

FIGURE 5.3: Participating States (shown in blue)

TABLE 5.1: Nominal Criteria used for Index, Range (0-7)

Element	**Nominal Criteria**
Statewide Project Management Office	=1 if state DoT has a statewide PMO
Policy Standards	= 1 if state DoT uses industry standards
Project Management Guidelines	= 1 if state DoT has defined guidelines
Centralization	= 1 if project teams must follow PMO guidelines
EVM	= 1 if EVM is used for major projects
Criteria for Application	= 1 if criteria is defined for application of EVM
Tailoring	= 1 if EVM practices are tailored according to project context

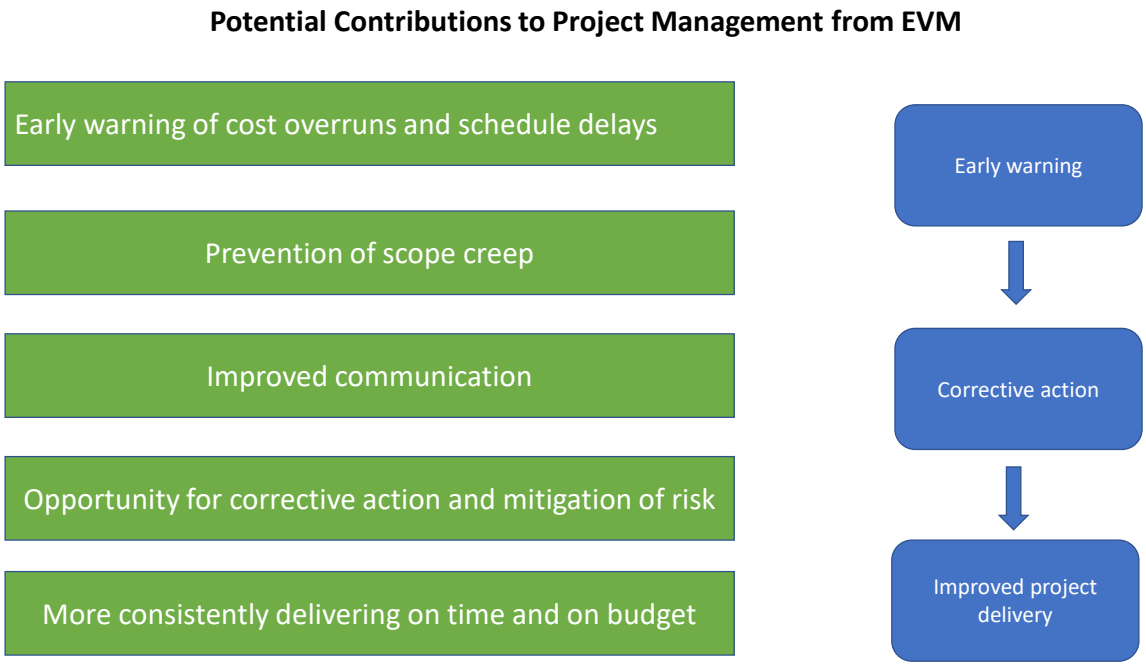

FIGURE 5.4: Potential Contributions to Project Management from EVM

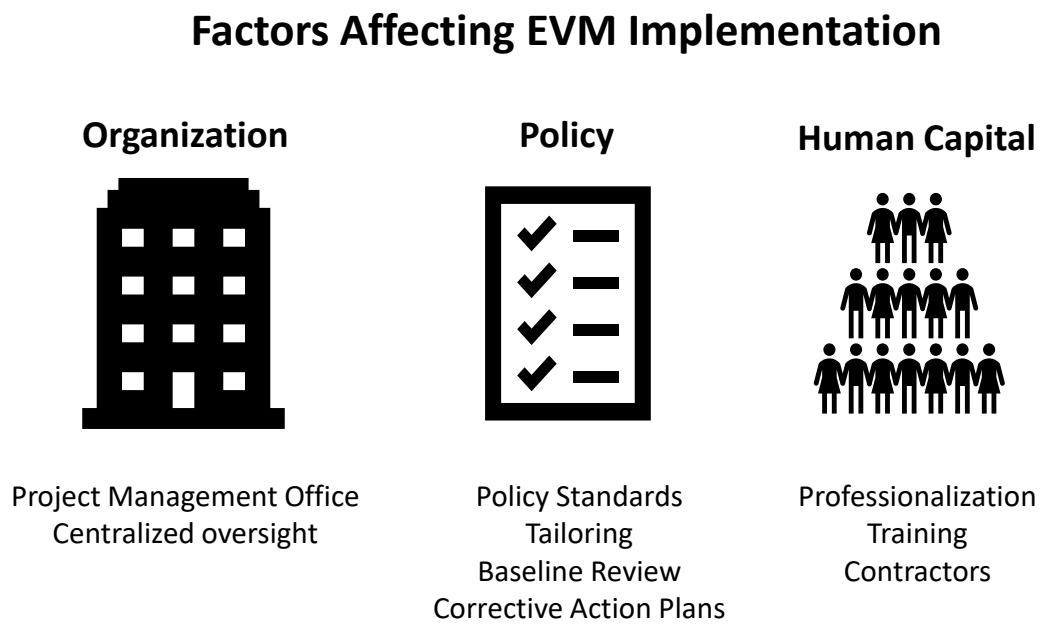

FIGURE 5.5: Factors Affecting EVM Implementation

Based on your experiences in state government managing transportation projects, indicate your perception regarding potential contributions to project management from EVM:

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
EVM is an effective early warning system for cost overruns	○	○	○	○	○
EVM is an effective early warning system for schedule delays	○	○	○	○	○
EVM helps prevent scope creep	○	○	○	○	○
EVM helps achieve cost objectives	○	○	○	○	○
EVM helps achieve schedule objectives	○	○	○	○	○
EVM indicators are effective in communicating project status in portfolio management	○	○	○	○	○
EVM helps facilitate corrective action	○	○	○	○	○
Overall, EVM is an effective performance management tool	○	○	○	○	○

FIGURE 5.6: Likert Questions, Contributions to Project Management from EVM

Based on your experiences in state government managing transportation projects, indicate your perception of the potential importance of the following factors to successful EVM implementation.

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Establishment of a centralized project management office	○	○	○	○	○
Adoption of EVM industry standards	○	○	○	○	○
Tailoring of EVM procedures for project context	○	○	○	○	○
Project Management Professionals (PMP)	○	○	○	○	○
EVM training programs	○	○	○	○	○
Contractor experience with EVM	○	○	○	○	○
Independent reviews of the performance baseline	○	○	○	○	○
Development of corrective action plans based on EVM indicators	○	○	○	○	○

FIGURE 5.7: Likert Questions, Factors Affecting Implementation

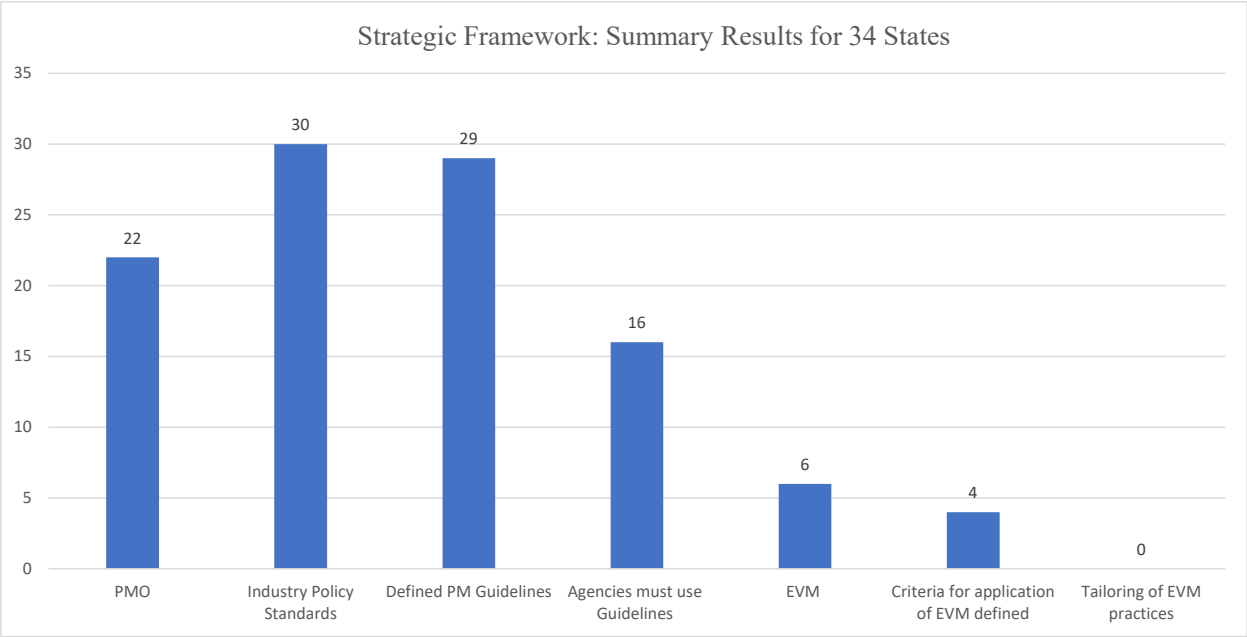

FIGURE 5.8: Summary Results for Strategic Framework

TABLE 5.2: Breakdown of Scores by State

State	Project Management Office	Industry Policy Standards	Defined PM Guidelines	Agencies must use guidelines	EVM	Criteria for Application	Tailoring EVM practices	Total
North Carolina	1	1	1	1	1	1	0	6
Washington	1	1	1	1	1	1	0	6
California	1	1	1	1	1	1	0	6
Virginia*	1	1	1	1	0	0	0	4
South Carolina	1	1	1	1	0	0	0	4
Georgia	1	1	1	1	0	0	0	4
Colorado*	1	1	1	1	0	0	0	4
Nebraska	1	1	1	1	0	0	0	4
Idaho	1	1	1	1	0	0	0	4
Wyoming	1	1	1	1	0	0	0	4
Oklahoma	1	1	1	1	0	0	0	4
New York	1	1	1	1	0	0	0	4
Nevada	1	1	1	0	1	0	0	4
Arizona	1	1	1	0	1	0	0	4
Indiana	1	1	1	0	0	0	0	3
Michigan	1	1	1	0	0	0	0	3
Texas*	1	1	1	0	0	0	0	3
New Jersey	1	1	1	0	0	0	0	3
Maryland	0	1	0	0	1	1	0	3
Iowa	1	1	1	0	0	0	0	3
Kentucky	0	1	1	1	0	0	0	3
New Mexico	0	1	1	1	0	0	0	3
Missouri*	1	1	1	0	0	0	0	3
Connecticut	0	1	1	1	0	0	0	3
Maine	0	0	1	1	0	0	0	2
Florida	1	1	0	0	0	0	0	2
Massachusetts	1	1	0	0	0	0	0	2
Utah	1	0	1	0	0	0	0	2
Minnesota	0	1	1	0	0	0	0	2
Vermont	0	1	1	0	0	0	0	2
South Dakota	1	0	1	0	0	0	0	2
Alabama	0	0	1	0	0	0	0	1
Arkansas	0	1	0	0	0	0	0	1
Mississippi	0	1	0	0	0	0	0	1

*EVM adoption planned in near future

Descriptive Statistics	
Range	1 to 6
Mean	3.2
St. Dev	1.3
Median	3
Mode	4

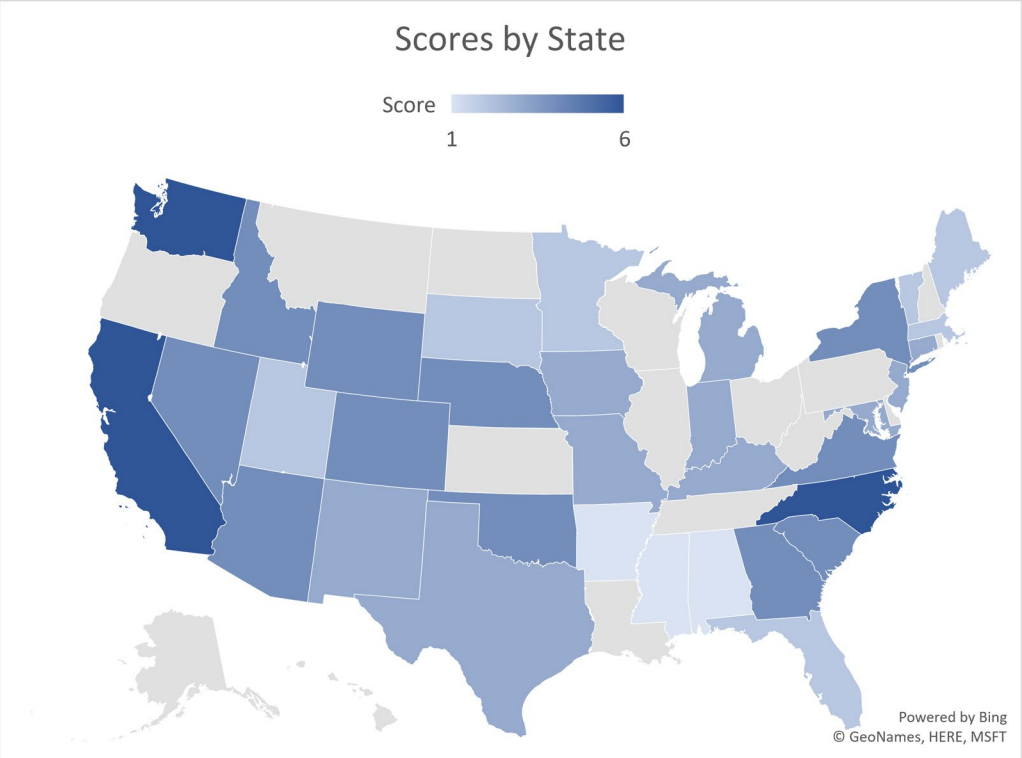

FIGURE 5.9: Scores by State

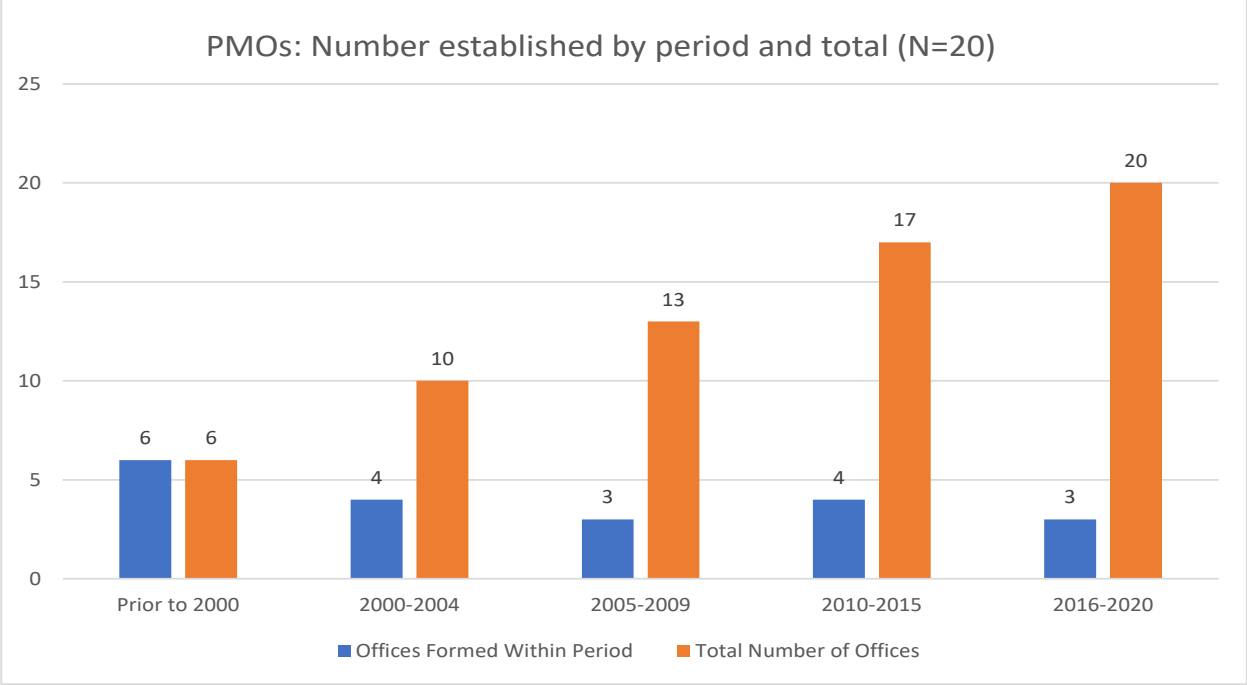

FIGURE 5.10: Statewide DoT PMO Chronology

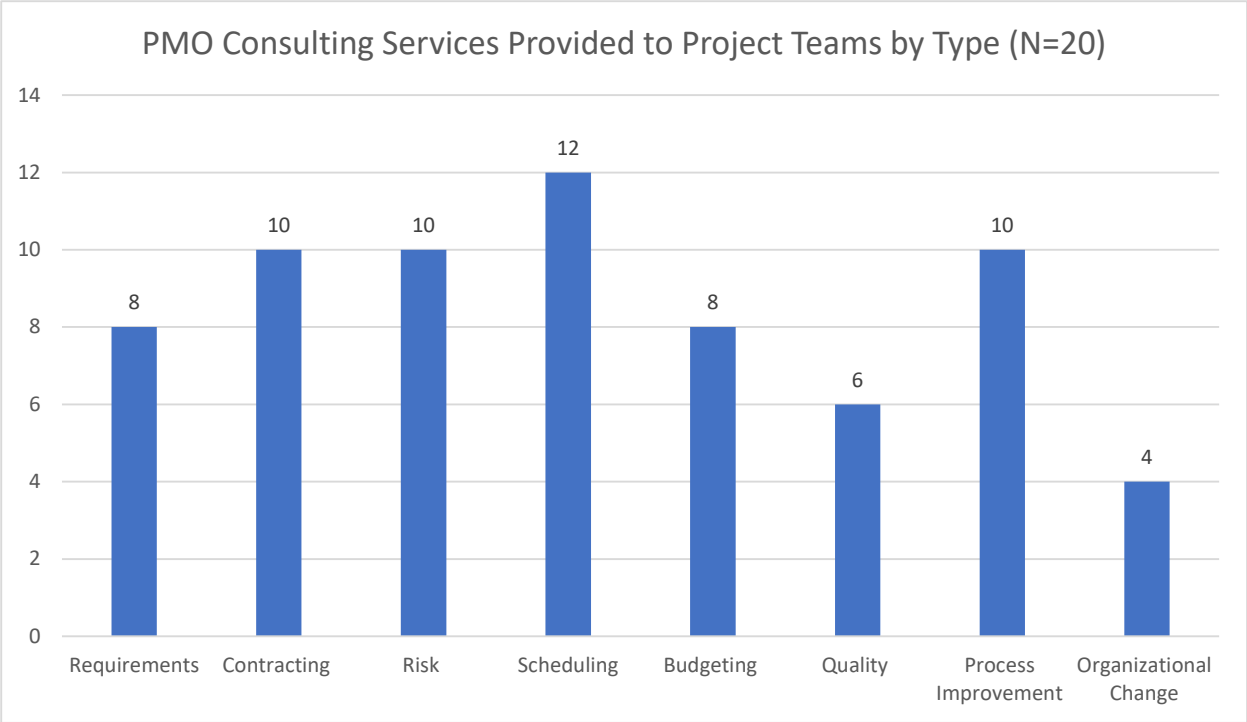

FIGURE 5.11: PMO Consulting Services

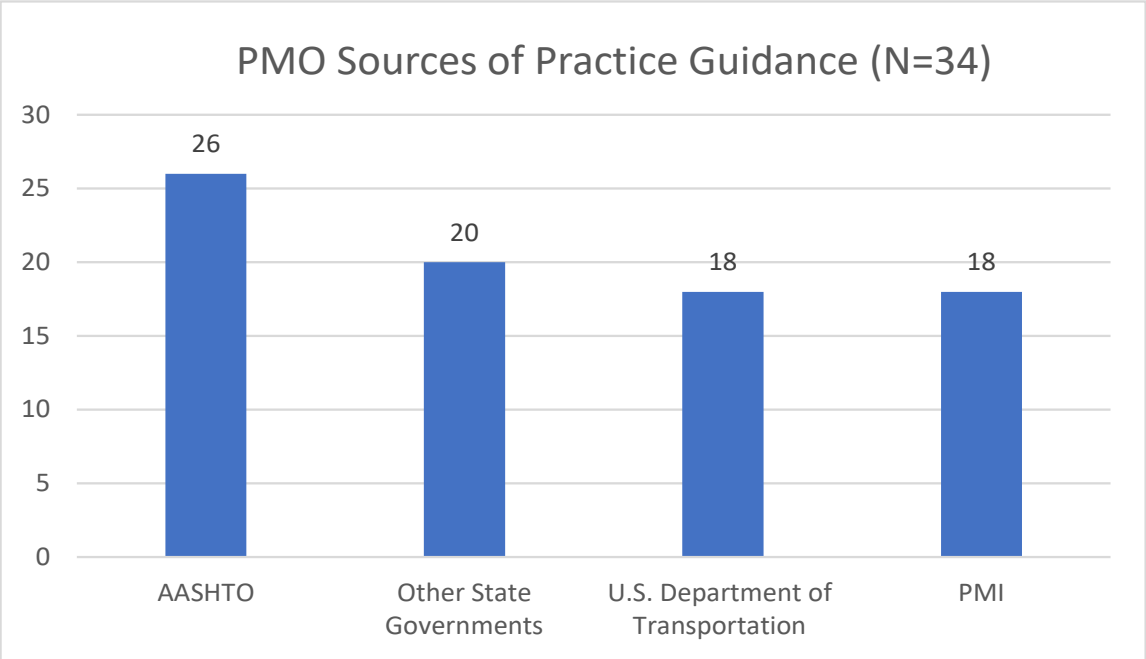

FIGURE 5.12: PMO Sources of Practice Guidance

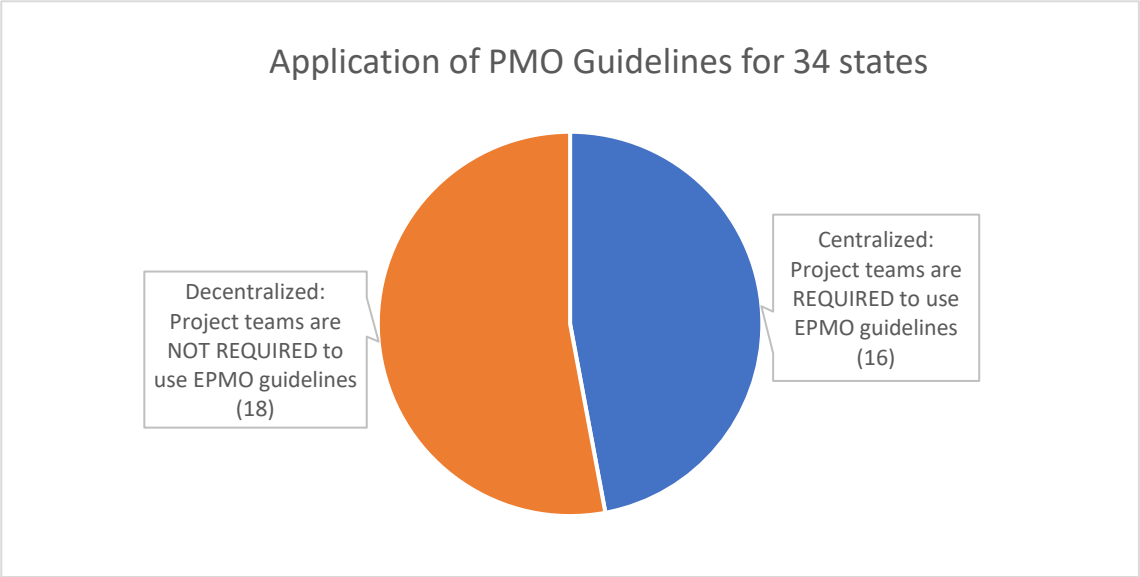

FIGURE 5.13: Application of PMO Guidelines

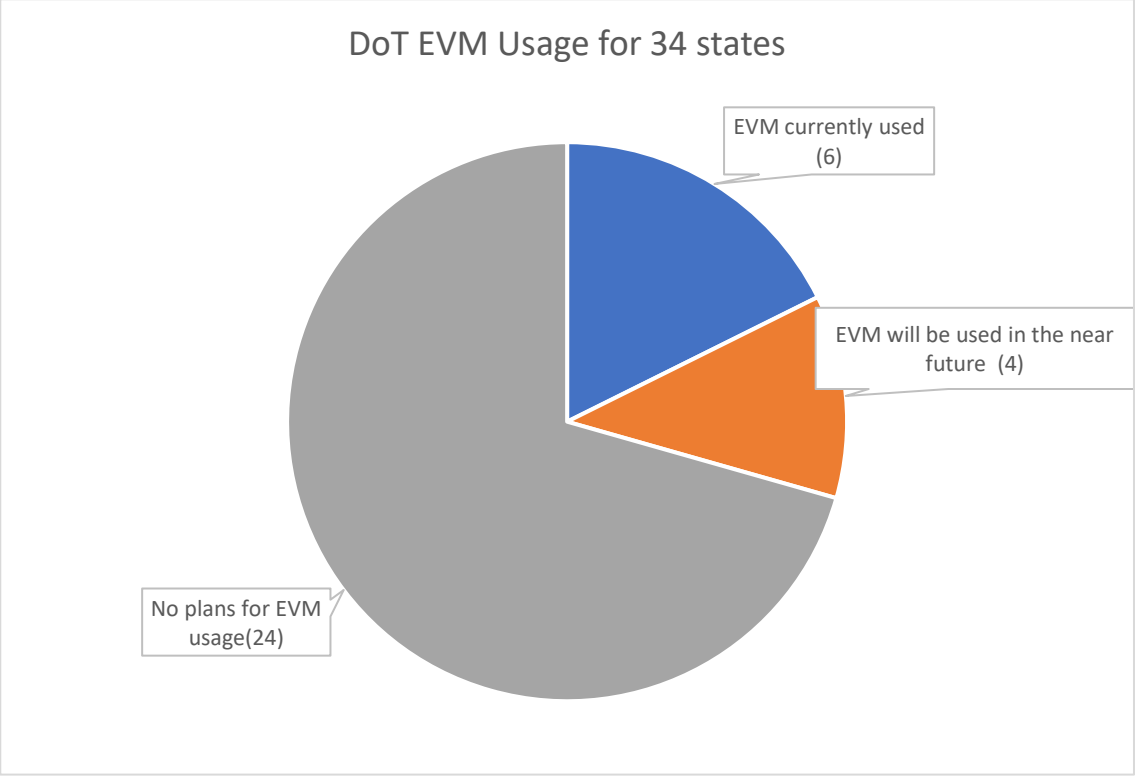

FIGURE 5.14: EVM Usage for 34 State DoTs

TABLE 5.3: Frequency Tabulation, Contributions to Project Management (N=6)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
EVM is an effective early warning system for cost overruns			1	**3**	2
EVM is an effective early warning system for schedule delays		1		**3**	2
EVM helps prevent scope creep		2	**2**	1	1
EVM indicators are effective in communicating project status in portfolio management				**4**	2
EVM helps facilitate corrective action			1	**4**	1
EVM helps achieve cost objectives				**5**	1
EVM helps achieve schedule objectives			1	**4**	1
Overall, EVM is an effective performance management tool			1	**3**	2

TABLE 5.4: Descriptive Statistics, Contributions to Project Management (N=6)

Contribution to Project Management	**Mean**	**Standard Deviation**	**Minimum**	**Median**	**Maximum**
Early Warning, Cost Overruns	4.17	0.75	3	4	5
Early Warning, Schedule Delays	4.00	1.10	2	4	5
Prevention of Scope Creep	3.17	1.17	2	3	5
Communication, Portfolio Management	4.33	0.52	4	4	5
Facilitation of Corrective Action	4.00	0.63	3	4	5
Achievement of cost objectives	4.17	0.41	4	4	5
Achievement of schedule objectives	4.00	0.63	3	4	5
Overall	4.17	0.75	3	4	5

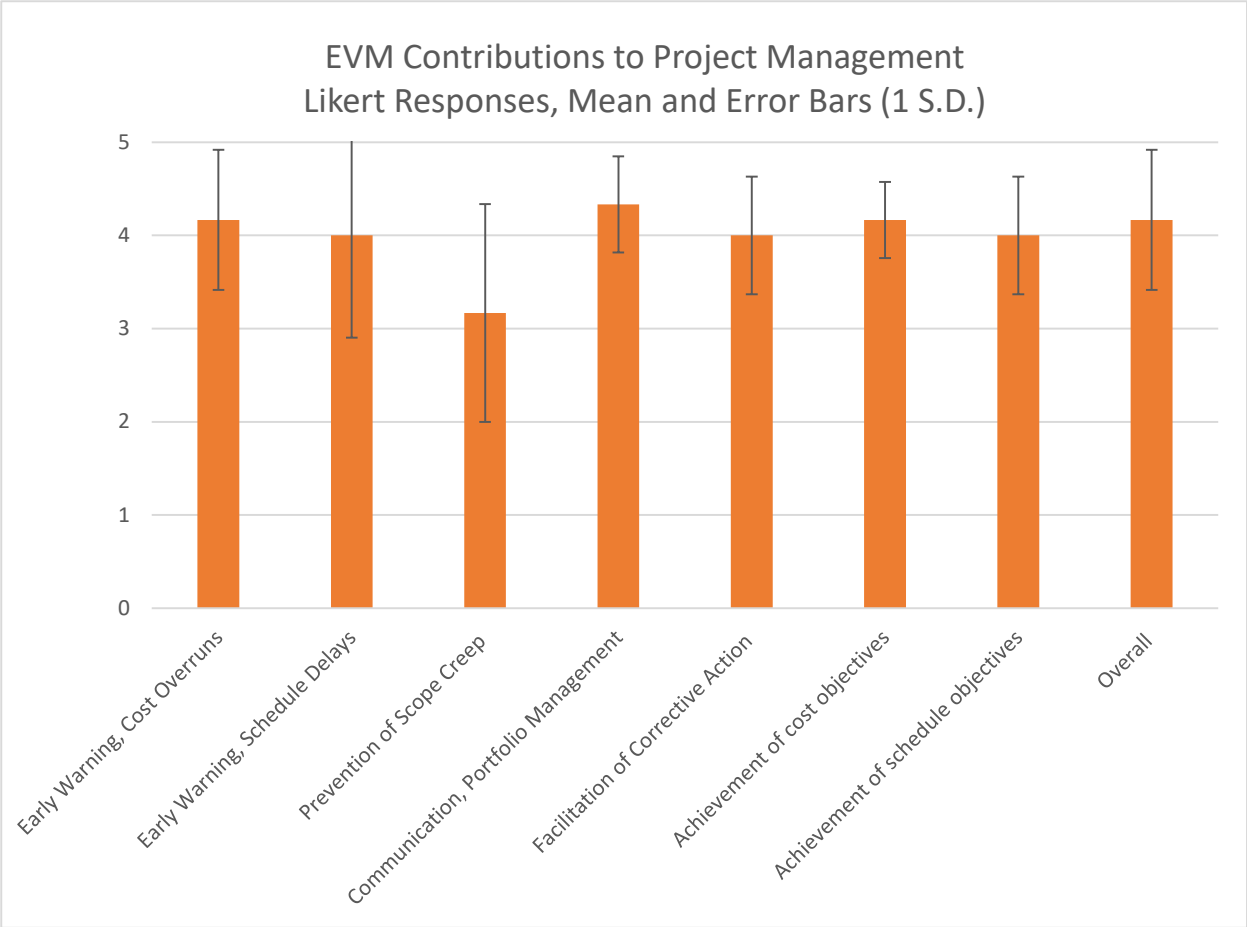

FIGURE 5.15: Contributions to Project Management (N=6)

TABLE 5.5: Frequency Tabulation, Factors Affecting EVM Implementation (N=6)

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Establishment of a centralized project management office		1	2	1	2
Adoption of EVM industry standards		2	**2**	1	1
Tailoring of EVM procedures for project context		1	**3**	1	1
Project Management Professionals (PMP)			**4**	1	1
EVM training programs		1	2	1	2
Contractor experience with EVM		2		**2**	1
Independent reviews of the performance baseline			2	**2**	2
Development of corrective action plans based on EVM indicators		1	1	**3**	1

TABLE 5.6: Descriptive Statistics, Factors Affecting EVM Implementation (N=6)

Factor Affecting Implementation	**Mean**	**Standard Deviation**	**Minimum**	**Median**	**Maximum**
Centralized PMO	3.67	1.21	2	3.5	5
Industry Standards	3.17	1.17	2	3	5
Tailoring	3.33	1.03	2	3	5
PMP	3.50	0.84	3	3	5
Training	3.67	1.21	2	3.5	5
Contractor experience	3.40	1.34	2	4	5
Baseline Review	4.00	0.89	3	4	5
Corrective Action Plans	3.67	1.03	2	4	5

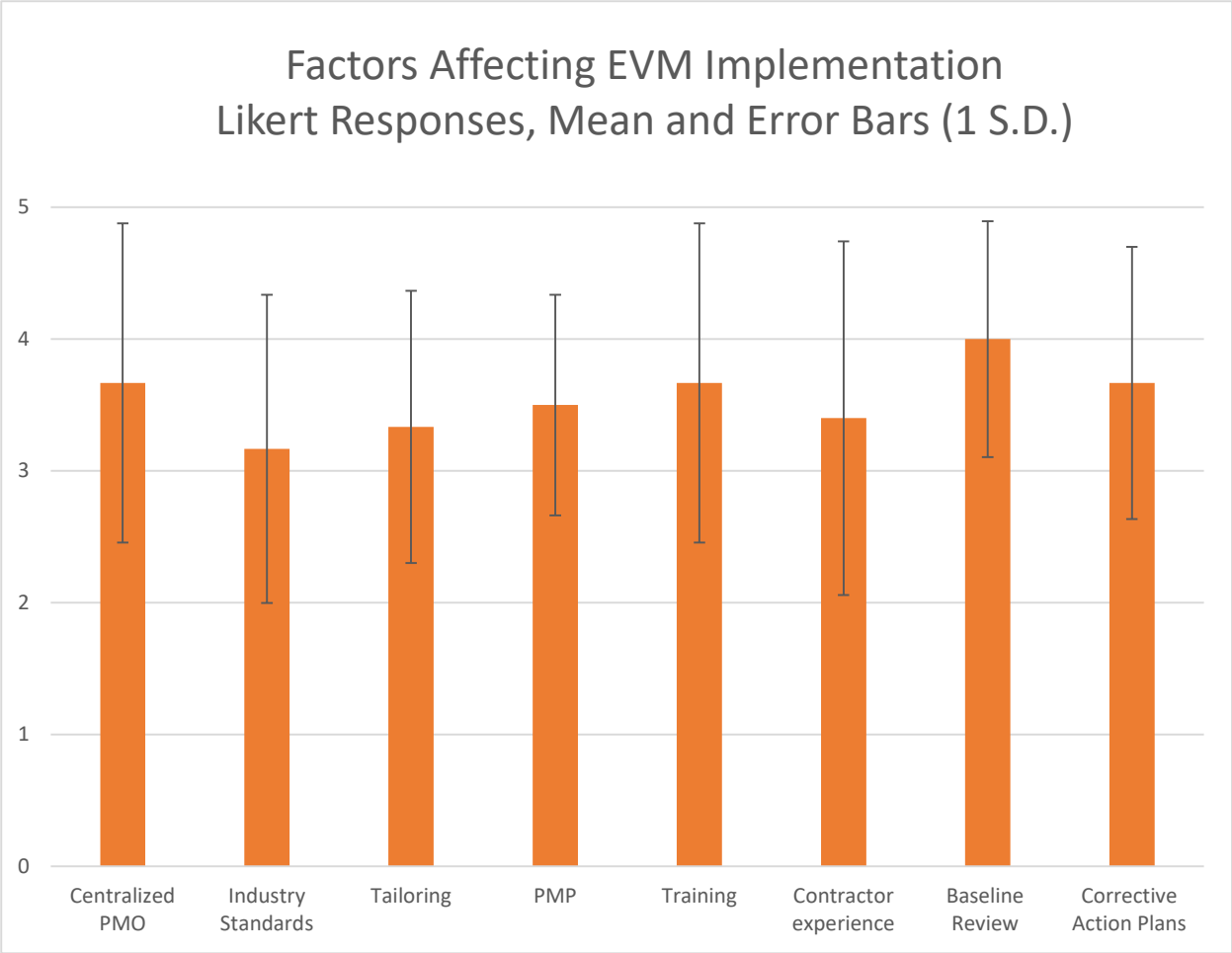

FIGURE 5.16: Factors Affecting EVM Implementation (N=6)

CHAPTER 6

CONCLUSION

As state governments confront the new era of megaprojects, improving the ability to effectively manage an increasingly expensive, complex, and diverse set of infrastructure projects is urgent. Over the last decade, annual transportation capital expenditures in state government have increased by almost 50%, growing from $49 billion in 2010 to $73 billion in 2019 (National Association of State Budget Officers, 2019). However, state infrastructure projects are not just getting costlier, they are becoming more complex, with the emergence of large-scale Information Technology (IT) acquisitions as a centerpiece of government modernization. Therefore, this research emphasizes that development of project management strategies is critical to avoid the potential consequences of the "Iron Law of Megaprojects: Over budget, over time, under benefits, over and over again" (Flyvbjerg, 2017).

Transportation capital expenditures will continue to be an important area of focus as state governments grapple with crumbling infrastructure. In its most recent assessment, the American Society of Civil Engineers rated America's roads, bridges, and transit systems as mediocre to poor, citing significant deficiencies in conditions and functionality, with increasing vulnerability to safety risks as transportation assets approach the end of their service life (American Society of Civil Engineers, 2017). Given the growing role of technology in state government, large scale IT acquisitions are part of the new normal, with planned replacements of legacy systems and needed cybersecurity investments. Finally, given recent revenue losses from COVID-19, the need to improve project management and realize cost savings has taken on a new level of importance.

Research in public management has identified project management as an essential component of a comprehensive capital budgeting process (Ammar, Duncombe, & Wright, 2001; Ebdon, 2004; Jimenez & Pagano, 2012; Srithongrung, Yusuf, & Kriz, 2019). However, aside from suggesting potential advantages of centralized project oversight, the field has not contributed research on modern project management strategies and results of their implementation in different project environments. To fill this important gap in the literature, this dissertation provided original research on use of EVM for major IT and transportation projects in U.S. state governments. Specifically, the three primary research questions of the dissertation for major IT and transportation projects were the following:

1. Have state governments adopted EVM as a component of their project management strategy?
2. What are the results of implementing EVM in state government?
3. What factors are critical for effective conduct of EVM in state government?

The concluding chapter begins by summarizing results for IT project management from Chapter 3 and 4. Next, it recaps findings for transportation project management from Chapter 5. Following this, a comparative analysis of IT and transportation is provided. It then explains the contributions of this research to project management, public management, and policy. The dissertation concludes by explaining how future research can build upon limitations of this study.

Summary of Results

Have states adopted EVM as a component of their Enterprise Project Management (EPM) strategy for IT projects?

A total of 31 state Enterprise Project Management Offices (EPMOs) responded to the electronic survey and 11 officers participated in follow-up telephone interviews. Results indicate that most states have taken key initial steps in executing their EPM strategy, such as establishing EPMOs, adopting industry standards, and defining project management guidelines. However, in

17 of the 31 states, agencies are not required to follow guidelines issued by the EPMO in executing their projects. Eighteen states currently use EVM for major IT projects; thirteen have no plans for EVM adoption in the near future. EVM is a new practice for IT project management in state governments, with the earliest evidence of use found, in Georgia, in 2004. Moreover, of the 18 states that currently use EVM, 15 have begun using it in the last decade. The style of EVM practiced is based on Project Management Institute (PMI) standards. As explained in chapters 2 and 3, PMI standards were developed to provide a leaner and less restrictive version of EVM for voluntary users than that mandated by the U.S. federal government. Thus, in comparison to the U.S. federal government, use of EVM for major IT projects in the states is relatively new, flexible, and decentralized.

What are the results of implementing EVM for major IT projects in state government? What factors are critical to effective conduct of EVM in this operating environment?

Findings from 17 states that currently use EVM indicate that it is an effective early warning system for cost overruns and schedule delays, improves communication, facilitates corrective action, and helps meet cost and schedule objectives. Overall, 15 of 17 state officers reported that EVM is an effective performance management tool. Importantly, certain factors are decisive in realizing these benefits on IT projects, such as establishing an EPMO, tailoring practices to fit project context, conducting independent review of performance baselines, developing corrective plans based on EVM indicators, reporting tools, and training programs. These results align closely with the general EVM body of knowledge, especially studies of use in U.S. federal agencies.

Three case studies of state EPMOs were presented in Chapter 4: New Mexico, Georgia, and Alabama. New Mexico, in which agencies and their individual project managers are given broad discretion in determining when to use EVM, gave insight into its decentralized application.

An officer from the state explained that EVM users met their cost and schedule objectives more consistently than non-users, simply because they have a better understanding of their true project status and risks, and more effectively communicate with the EPMO. The case study of Georgia provides perhaps the most intriguing findings, specifically a collaborative evaluation technique used in a centralized environment where EVM is a requirement for major projects. By surveying project stakeholders to capture their perceptions, the EPMO is given a more complete picture of project status, occasionally providing early warning that EVM reported solely by the project manager would not reveal. The case of Alabama underscored the importance of project management maturity as a precondition for effective conduct of EVM. Following a major project failure, Alabama was aggressive with a statewide rollout of EVM, with an officer describing the experience as "guns blazing." Ultimately, this "guns blazing" approach exposed weaknesses in core competencies that must be rectified before EVM can be conducted for greater effect in the future.

Have states adopted EVM as a component of their transportation project management strategy?

A total of 34 state Departments of Transportation (DoTs) completed the electronic survey and eight officers from different states contributed by engaging in follow-up telephone interviews. For the strategic framework, most states have established statewide PMOs for transportation project management, adopted industry standards, and defined their project management guidelines. Yet in 18 of 34 states, project teams are not required to practice guidelines as specified by the statewide PMO. EVM is currently used in six states, four have plans for adoption in the near future, and 24 have no plans for EVM adoption. The style of EVM practiced for transportation projects is also based on PMI standards. With respect to the three primary research questions of this dissertation, Chapter 5 most adequately addressed the one

regarding adoption of EVM. Results for EVM implementation are limited because only six of 34 states currently implement the strategy.

What are the results of implementing EVM for major transportation projects in state government? What factors are critical to effective conduct of EVM in this operating environment?

Results from six state DoTs that currently use EVM indicate that it has provided early warning of cost overruns and schedule delays, improved communication, given opportunity for corrective action, and helped project teams achieve their cost and schedule targets. Overall, five of the six transportation officers reported that EVM was an effective performance management tool. Factors cited as very important for realizing the intended benefits of EVM include the establishment of a centralized office, adoption of PMI standards, independent reviews of performance baselines, development of corrective action plans based on EVM indicators, training programs, and reporting tools. The findings on IT project management in this dissertation align with the established EVM literature.

Case studies were provided for California, North Carolina, and Texas. The case of California highlighted innovative approaches to project delivery, such as streamlining environmental review and conducting value analysis studies, which have resulted in significant cost savings required by recent legislation. California provided an example in which EVM has been practiced effectively on a voluntary basis by "savvy" project managers for at least a decade, in advance of forthcoming EVM requirements. The case of North Carolina provided an example of an environment in which EVM is currently a requirement. North Carolina DoT has gained a reputation for delivering "on time and on budget," as evidenced by its stellar results in project delivery; over 90% percent of construction projects completed on schedule, with less than a 2% total budget overrun, in Fiscal Years 2018 and 2019. Officers speaking about this success in

project delivery noted EVM as one of several factors critical to achieving these results. Texas provided an illustration of a state that has yet to use EVM but is in the process of drafting policy and determining how to pilot it on major projects. Currently, Texas DoT delivers roughly two-thirds of its construction projects on schedule. In response to pressure from the state legislature to deliver more construction projects on schedule, EVM is being adopted to improve the timeliness of project delivery.

Comparative Analysis

Because IT and transportation were studied using the same design, a comparative analysis can be provided for the strategic framework and implementation of EVM. Regarding the strategic framework, practice of EVM is more prevalent for IT than transportation, with 18 of 31 states using it for IT and only six of 34 states using it for transportation. Therefore, the average policy score for IT (4.5) is greater than it is for transportation (3.2).[40] When considering just the non-EVM components of the framework on a scale of 0 to 4, the average policy score for IT (3.2) is also greater than it is for transportation (2.9). [41] This difference in front-end scores can be attributed to a higher proportion of state governments establishing centralized project management offices for IT (87%) than for transportation (71%).

Some motives for creating these central offices are shared between IT and transportation, including the desire to improve project delivery by establishing recognized policy standards, getting more consistent application of guidelines, and building project management capacity. However, the desire to improve project delivery for IT was often in response to large-scale project failures and persistent cost overruns and schedule delays. In contrast, the study did not

[40] Significance at $P < 0.01$. Please see Appendix A for comparison of means.
[41] This refers to total scores for the first four components of the framework: office, standards, guidelines, and centralization. The difference is not statistically significant ($P > 0.1$).

find large-scale project failures to be an ordinary motive for establishing statewide PMOs for transportation. Instead, motives typically involved the sheer cost of transportation projects and a desire to proactively manage financial risks and improve the timeliness of project delivery.

Another point of variation for IT and transportation PMOs regards their scope of operations. At the summary level, the operations of most EPMOs are not limited to project delivery: they also involve investment prioritization. As explained in Chapter 3, EPMOs often work with agencies to develop business cases and provide the governor's office with recommendations for IT investments. However, such activity was not typical for transportation, which were limited to project delivery. In this regard, while project management reforms for IT have reached all phases of the budgeting process, transportation has been mostly limited to budget execution, audit, and evaluation. The following section relates this to budget reform literature.

The vast majority of states have adopted industry policy standards for IT and transportation projects. However, policy standards are more comprehensive for IT than for transportation. Each of the 31 EPMOs surveyed in Chapter 3 have adopted PMI standards for IT. However, only 18 of the 34 state DoTs surveyed have adopted PMI standards. As explained in Chapter 5, PMI standards are the most comprehensive in defining practices and explicit in recommending use of EVM when considering other transportation project management guidelines, such as those issued by US DoT and the American Association of State Highway and Transportation Officials. For this reason, multiple state DoTs adopted PMI standards to develop more comprehensive policy. Thus, for transportation, PMI standards have been important in compensating for the weaknesses of legacy policy standards. In contrast, the adoption of PMI

standards for IT represented a shift from essentially nothing to something because no standards were found to exist prior to their adoption.

PMI standards have been instrumental for the adoption of EVM in U.S. state governments. As reported in Chapter 3, the most typical reason given for adopting EVM for IT projects is its status as a PMI best practice. In fact, only two of the 18 states that currently use EVM for IT projects utilized federal EVM guidelines in developing their policy: all cite PMI. PMI standards are also a driving force for transportation. Of the 18 state DoTs that have adopted PMI standards, nine either use EVM now or plan to in the near future.

Regarding implementation of EVM, because this dissertation provides analysis of 18 states that currently use it for IT projects and six that presently use it for transportation projects, the findings for IT are more telling than those for transportation. However, both IT and transportation officers reported similar benefits of implementing the strategy in their respective operating environments, supporting EVM contributions to project management. These benefits include early warning of cost overruns and schedule delays, improved communication, opportunity for corrective action, and achievement of performance objectives. The results from the two different operating environments align closely. For example, each potential contribution to project management analyzed had the same median rating (see Frequency Tables in Chapters 4 and 5). That is, with the exception of preventing scope creep, officers "agreed" that EVM provided all benefits for both project types.

Several factors affecting implementation emerge as important for successful use of EVM in both IT and transportation. These include the establishment of a centralized project management office, adoption of PMI standards, reporting tools, independent reviews of performance baselines, development of corrective action plans based on EVM indicators, and

training programs. One factor that took on more importance for IT than it did for transportation was tailoring of practices to align with project context. As explained in Chapters 3 and 4, EPMOs have taken steps to align their EVM practices with agile approaches to project management. For example, EPMOs have worked with agencies to show how points can be assigned to user stories, enabling EVM by tracking progress based on points earned, and integrating this with financial data. In contrast, all state DoTs described their current EVM strategy as developing a common set of procedures for use across projects. In this regard, more tailoring of EVM may be necessary for IT to establish measures of progress, while transportation measures of progress can be more straightforward, such as miles of road completed for a highway project.

Contributions of Research

This research provides several contributions to project management, public management and policy literatures. Recently, PMI has been critical of project management research, citing the lack of studies conducted on project governance and enterprise project management strategies (Project Management Institute, 2016). This dissertation provided original research on project governance and enterprise project management strategies in U.S. state governments. Findings indicate that state governments have developed more comprehensive strategies for managing IT projects than transportation, as evidenced by greater involvement in project selection, use of stronger policy standards, and application of EVM.

Regarding the EVM body of knowledge, this study expands the domain of coverage on usage in the public sector. To date, previous research on use of EVM in the public sector has been limited to analysis of the U.S. federal and other national governments. This dissertation provided original research on EVM in U.S. state governments for IT and transportation projects.

In doing so, it chronicled the past, present, and future of the practice in U.S. state governments, improving our understanding of the historical evolution of EVM. Notably, the 50-year history of EVM in the U.S. federal government had essentially no direct impact on the practice in state government. However, its indirect impact can be traced to the PMI's initiative to offer a less imposing EVM system for voluntary users than that mandated by the U.S. federal government. Ultimately, EVM adoption in state government can be attributed to PMI's issuance of a leaner and less restrictive version of EVM in 2005 that was intended to simplify implementation.

States that implemented EVM reported several benefits of application consistent with established literature (Christensen & Heise, 1993; Christensen & Payne, 1992; Song, 2010; U.S. Government Accountability Office, 1997, 2009a). Such benefits include early warning of performance issues, improved communication, opportunity for corrective action, and better achievement of performance objectives. These results illustrate that EVM can serve as an effective performance management tool in the public sector, with less imposing standards than U.S. federal guidelines. In addition, results for IT indicate that EVM can be used effectively with agile styles of project management. Regarding factors affecting implementation, results are also consistent with established literature (Christensen, 1998; Kim, Wells Jr, & Duffey, 2003; Song, 2010; U.S. Government Accountability Office, 1997, 2008, 2009a, 2009b, 2012, 2016, 2019).

For public management and policy, contributions of this research span performance management, public budgeting and financial management, policy implementation, and emerging new public governance concepts. Performance management and budgeting literature have studied agency- and program-level operating metrics (Ho, 2018; Joyce, 2011; Lu, Willoughby, & Arnett, 2011; Lu & Willoughby, 2019; Moynihan, 2008). However, it has yet to give explicit focus to context of project management reforms and use of real-time indicators to manage costly,

complex, and diverse portfolios of public infrastructure projects. This dissertation helped fill this gap in the literature by exposing a hidden set of reforms aimed at improving capital project delivery.

Public sector performance is a multidimensional concept (Bouckaert & Halligan, 2008; Boyne, 2003; Lu & Willoughby, 2019; Selden & Sowa, 2004; Talbot, 2010; Walker, Boyne, & Brewer, 2012). Scholars of public management have researched possible sources of improvement in public performance attributable to a variety of factors, such as resources, regulation, market structure, organization, and management (Boyne, 2003; Walker et al., 2012). Yet research on strategy and public performance has been relatively limited (Walker, 2012). Specifically, regarding capital project management, scholars of public management have yet to study strategies to improve project delivery, aside from noting potential advantages of centralized project oversight (Ammar et al., 2001; Ebdon, 2004; Jimenez & Pagano, 2012; Srithongrung et al., 2019).

Findings from this dissertation are important for demonstrating that EVM can be an effective capital project management strategy for improving cost and schedule performance. Given the tremendous financial risks associated with costly and complex acquisitions, need to replace crumbling infrastructure, reduce cybersecurity vulnerabilities, and unprecedented revenue shortfalls from COVID 19, these results are especially timely for policymakers and public managers. For the academic field of public management, these findings are overdue, given the 50-year history of EVM in the U.S. federal government and its complete lack of coverage on the topic. Simply put, it is time for the academic side of public management to begin “turning the project management lights on” so that it can provide some type of meaningful advice to practitioners responsible for delivering capital projects, especially such high-cost and complex

ones. In this respect, EVM is another illustration of a gap between theory and practice in public management.

However, it cannot be stressed enough that several factors are decisive for realizing the intended benefits of EVM, as exposed in this dissertation. For policymakers, the key takeaway is that they have a unique and powerful set of tools at their disposal to structure the implementation process (Mazmanian & Sabatier, 1989; O'Toole, 2000). One of the most critical of these is the adoption of PMI standards, because they are comprehensive in defining practices and explicit in calling for use of EVM. These findings align with research on performance budgeting law in the states (Lu et al., 2011). Specifically, detailed instructions on the development, reporting, and use of performance data in law contribute to stronger use of performance budgeting systems in state governments. At the same time, it is critical to not delimit the role of a central project management office to oversight, and to avoid a strict command and control structure. Instead, central project management offices can also provide training, mentorship, consulting services, and avenues to professionalization, consistent with Moynihan's (2009) conception of knowledge generation and support of agency-driven changes for central offices.

The evolution of EVM has key points in common with foundational budgeting literature. Regarding the federal EVM experience, early reforms emphasized control and subsequent ones emphasized management, consistent with Schick's seminal analysis of budget reform in the U.S. federal government (Schick, 1966). Findings from this dissertation strongly support the notion that successful budget reform requires serious consideration of the dynamic objectives and needs of practitioners (Forrester & Adams, 1997). In this case, project and portfolio managers need management tools that can quickly detect problems and provide opportunity for corrective action and mitigation of risk so that cost and schedule performance objectives can be met. Finally,

EVM provides another illustration of the importance of performance information for budget execution, allowing for metric analysis to inform budget management (Ho, 2018; Joyce, 2011; Lu & Willoughby, 2019; Melkers & Willoughby, 2001; Moynihan, 2008). Ultimately, EVM can be considered a hidden New Public Management reform (Osborne & Gaebler, 1992). Reforms aimed to establish high levels of accountability for the results of government spending while giving discretion to achieve results are consistent with Moynihan's performance management ideal type (Moynihan, 2008, p. 33).

This research also uncovered reforms related to capital budget preparation and approval. As foundational budgeting literature explains, executive leadership is accepted because it facilitates legislative control (Abney & Lauth, 1989). As described in Chapter 3, many states have centralized responsibility for budget preparation in their EPMO for IT projects. Prior to reforms, agencies often developed their own procedures for business case analysis and investment justification, rendering a growing number of requests for costly IT projects non-comparable, confusing, and unwieldy. Centralizing responsibility for budget preparation in the EPMO helped provide an enterprise view of technology needs and more thorough investment analysis.

Finally, this research is important for governing and managing the next generation of costly, complex, and diverse public infrastructure projects. The contracting literature has examined how governments can develop more effective contracting rules for complex acquisitions (Brown, Potoski, & Van Slyke, 2013). However, the field of public management has a limited understanding of the broader field of acquisition management because of its lack of coverage on project management. Similar to capital budgeting and its narrow focus on financing costs, acquisition management focuses on front-end activities, stopping short of what is actually

needed to get the real job done—that is, project management. Recently, public management research has called for attention to agile as a general and project management style (Mergel, Ganapati, & Whitford, 2020), finding that state governments have adopted agile principles for IT project management. Importantly, many have successfully married agility components and EVM, providing project and portfolio managers with the flexibility and structure needed to pivot quickly to accommodate change.

Future Research

Future research can improve on the some of the limitations of this study. To address the relatively low number of participants, scholars may survey additional EVM users in states that currently use EVM. For IT, use of EVM appears to be likely in health agencies and DoTs that purchase expensive systems. A few state IT officers recommended future research on state university systems and their respective EPMOs, since 1) technology is central to service delivery in this operating environment, and 2) many university systems do not fall under the oversight of the state EPMO, despite their acquisition of costly IT systems. Instead, they are typically given discretion in developing their own policies. For transportation, EVM users can be surveyed in states with widespread use, such as North Carolina, California, and Maryland.

To address the subjective nature of perceptual measures, research using archival data could use the same dimensions of performance as dependent variables and factors affecting implementation as independent variables. However, project-level data can be difficult to find, and, when available, typically has estimated costs, completion dates, and corresponding actuals. The challenge with conducting such quantitative research is that data is needed on how the project was performing throughout execution—this has been firmly established by the EVM body of knowledge. Without data on how projects are performing during execution, such as the

Cost Performance Index at 20% complete, models are recognized as underspecified, and unlikely to be published in modern project management journals (Willems & Vanhoucke, 2015).

Another intriguing line of research involves textual analysis of documents in project data libraries, especially narratives for project status reports and lessons learned repositories. Such research may unearth some of the primary reasons for performance issues on capital projects and lessons learned in managing these risks. For example, analysis of IT project status narratives may demonstrate how evolving scope definition, such as adding new features to an application, contributes to schedule changes that have budgetary impacts. In Georgia, analysis of such narratives may illustrate general benefits of participatory evaluation techniques that incorporate perspectives of multiple project stakeholders. On lessons learned repositories, New Mexico has begun to compile records to facilitate knowledge dissemination. Analysis of these types of reports may reveal successful strategies for coping with the difficult operating environment of IT project management. For transportation, project status narratives may show the types of risks that are likely to delay a project, such as environmental review, leading to cost escalation.

Finally, the participatory evaluation technique discovered in Georgia can be explored further. The approach is promising, given reported benefits, its simplicity, and its fit with agile principles. By incorporating the perspectives of multiple stakeholders in real-time, the EPMO has been given opportunity for corrective action unavailable from project manager reports alone. Part of the virtue of the technique is its simplicity: it only requires that surveys to be sent to stakeholders, capturing their perceptions through Likert questions and open-ended responses. It also fits well with agile principles, specifically in taking a collaborative approach to evaluation and facilitating constant communication between the EPMO, project managers, developers, and, ultimately, end-users.

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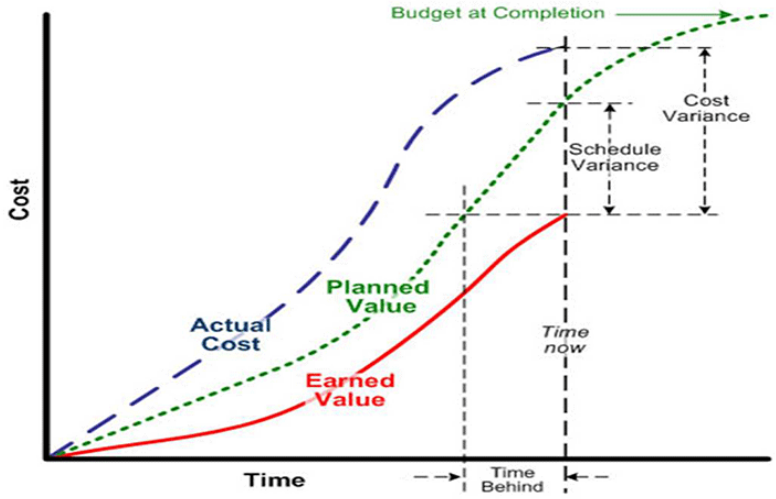
APPENDIX A

APPLYING EARNED VALUE MANAGEMENT: AN EXAMPLE

Earned Value methodology integrates three fundamental elements of project management data: scope, schedule, and cost (Anbari, 2003). A few key terms in EVM are *Planned Value*, *Earned Value*, and *Actual Cost of Work Performed*. Planned value is the budgeted cost of work scheduled and is used to establish a performance baseline. Earned value is the budgeted cost of the work actually performed and is used to recognize progress against the baseline during execution.

Referring to Figure 1, at any given point in time for a project, a meaningful cost variance can be calculated by comparing earned value to the actual cost of work performed *(Actual Cost)* as measured on the vertical axis. Importantly, a meaningful cost variance cannot be calculated by comparing planned to actual cost. For example, in Figure 1 at "time now", the project is behind schedule- earned value is less than planned value. Therefore, comparing planned to actual cost would understate the cost variance as shown on the vertical axis. In any case, the only way to accurately measure cost variance is by comparing earned value to actual cost. Figure 1 also shows that schedule variances can be quantified in units of time and money by comparing planned value to earned value on the horizontal and vertical axis, respectively.

FIGURE A.1
Earned Value Methodology*

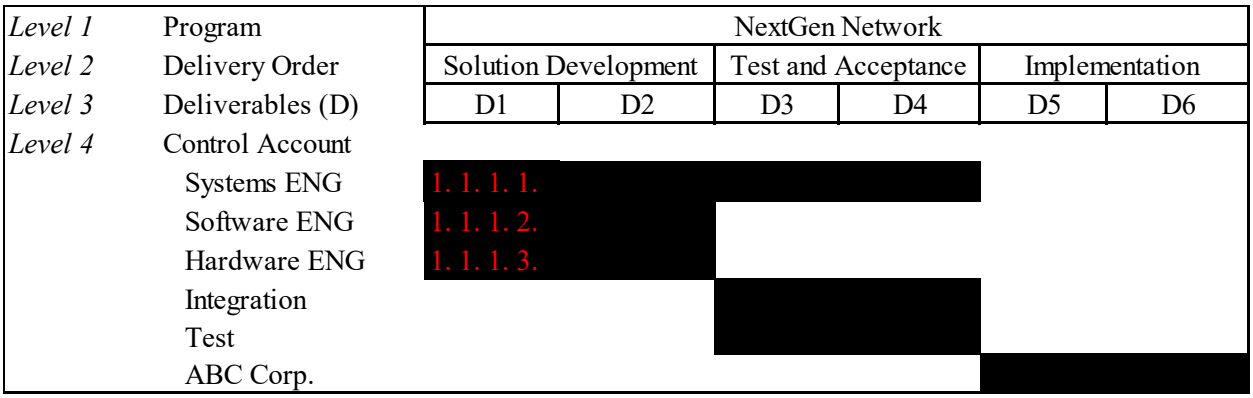


***This image is from planningengineer.net**

A hypothetical example is now presented to demonstrate how to use earned value methodology. To integrate the scope, schedule, and cost data, a Work Breakdown Structure (WBS) and a Performance Measurement Baseline (PMB) must be developed. The WBS is shown in Figure 2. In many ways, the WBS for a project serves a similar purpose that an organizational chart does for an organization (Fleming & Koppelman, 2010). The WBS decomposes and organizes the work to be performed into major categories and assigns responsibility for activities to functional groups and/or organizations. Here, the WBS has four levels: program, delivery order, deliverable, and control account, as indicated by the far left of Figure 2. For each deliverable, functions are assigned responsibilities for completing activities in control accounts (shaded in black). The following example illustrates how EVM data can be used to analyze performance data for Deliverable 1. In passing, note that the WBS shows that systems

engineering, software engineering, and hardware engineering are each responsible for activities related to Deliverable 1.

FIGURE A.2
Work Breakdown Structure



As the top of Table 1 shows, Deliverable 1 has an estimate at completion expressed in units of money ($1,000) and time (6 months). Each unit of time has an assigned production value, monthly planned value, equal to the budgeted cost of work scheduled for that month. The schedule of planned values becomes the Performance Measurement Baseline (PMB). Within each unit of time, planned values are identified for each functional group.

Table 1: EVM Example

	Phase 1		Phase 2			Phase 3	
Function/Time	1	2	3	4	5	6	Complete
1	$ 75	$ 100				$ 75	$ 250
2			$ 125	$ 150	$ 150		$ 425
3			$ 150	$ 175			$ 325
Monthly Planned Value	$ 75	$ 100	$ 275	$ 325	$ 150	$ 75	**$ 1,000**
Cumulative Planned Value	$ 75	$ 175	$ 450	$ 775	$ 925	**$ 1,000**	

	Phase 1		Phase 2			Phase 3	
Function/Time	1	2	3	4	5	6	Complete
1	$ 75	$ 100					
2			$ 100				
3			$ 125				
Monthly Earned Value	$ 75	$ 100	$ 225				
Cumulative Earned Value	$ 75	$ 175	$ 400				

	Phase 1		Phase 2			Phase 3	
Function/Time	1	2	3	4	5	6	Complete
1	$ 75	$ 110					
2			$ 125				
3			$ 150				
Monthly Actual Cost	$ 75	$ 110	$ 275				
Cumulative Actual Cost	$ 75	$ 185	$ 460				

The methodology is used to assess schedule performance by comparing planned value to earned value. For simplicity, suppose that Deliverable 1 consists of only discrete work meaning that the activity can be planned and measured and yields specific milestone outputs. In the first month, the planned value of $75 is comprised of three milestones, each with resource estimates of $25. At the end of the month, systems engineering completed all three of the milestones. Therefore, earned value is $75. Denoting the planned values accrued as earned value in month i as EV_i, earned value at time t is,

$$Earned\ Value_t = \sum_{i=1}^{t} EV_i$$

A S*chedule Variance* (in units of money) is the difference between earned value and planned value.[42]

$$Schedule\ Variance_t = Earned\ Value_t - Planned\ Value_t$$

At the completion of the third month, cumulative earned value is $400 and planned value is $450 (see Table 1). A schedule variance of -$50 would be reported to communicate the progress of the schedule in units of money. The *Schedule Performance Index* (SPI) is the ratio of *Earned Value* to *Planned Value* and indicates that for each $1.00 of work planned only $0.89 of work has been performed at the end of the third month.

$$Schedule\ Performance\ Index_t = \frac{Earned\ Value_t}{Planned\ Value_t}$$

Having analyzed schedule progress, the next step is to analyze cost performance. A *Cost Variance* is the difference between earned value and the actual cost of work performed.

$$Cost\ Variance_t = Earned\ Value_t - Actual\ Cost_t$$

Moving to the end of month 3, the cumulative earned value is $400, but the actual cost of performing that work is $460. Because it has cost $460 to complete $400 of planned value, there is a cumulative cost variance of -$60. The *Cost Performance Index (CPI)* is the ratio of earned value to actual cost and indicates that for each $1.00 spent, the team is earning only $0.87 of planned value.

$$Cost\ Performance\ Index_t = \frac{Earned\ Value_t}{Actual\ Cost_t}$$

Whereas additional analysis must take place to determine if the deliverable will be late, the cost data is cause for immediate concern. Fortunately, performance is being measured at monthly intervals, so the variance is detected in the third month. If performance were measured at the end of each phase, the variance would not have been quantified, detected, and communicated until the completion of phase 2, or two months later. An *Independent Estimate at Complete (IEAC)* is used to forecast the total cost of the deliverable, using the CPI. Specifically, the *IEAC* takes the cost incurred to date (AC) and adjusts the estimate for the cost of remaining work according to the efficiency of work performed to date by using the *CPI*.

$$IEAC = AC + \frac{Planned\ Value - Earned\ Value}{CPI}$$

Using the IEAC, the forecasted cost of the deliverable is $1,150, or 15 percent higher than the original budget. In this case, EV methodology is acting as an early warning system for a potential cost overrun. The government and prime contractor must now explore corrective action plans. The prime contractor must first reconcile their bottoms-up estimate with the IEAC. In complex contracting, it may simply be the case that the scope of work was incompletely defined at contract award and the contractor and government discover and agree that additional funding is needed to complete the full technical scope (Abba, 2000; Brown, Potoski, & Van Slyke, 2009). A corrective action plan may involve issuing a change order to ensure that the full technical scope is delivered. Alternatively, the corrective action plan may involve reducing the scope of work or units delivered to stay within budget.

Dilemmas to add money or time or reduce production quantities, or a combination of these, have been a recurring theme in defense acquisition history (Abba, 1997, 2000). The cancellation of the Navy's A-12 stealth medium-bomber program in 1991 helped establish the IEAC's role in federal EVM reporting after a study found significant stability in the CPI over the life of defense contracts (Christensen & Heise, 1993). Following the cancellation of the program, DoD required that any contractor's bottoms-up estimate at completion that was lower than the IEAC be justified in writing.

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[42] To quantify schedule variance in units of time requires either the Earned Schedule (Walt Lipke, 2006) or Earned Duration method (Khamooshi & Golafshani, 2014). These are both derived from EVM. To focus the paper, details on these have been minimized.

APPENDIX B

STATE IT SURVEY

State Project Management Office Survey

Start of Block: Informed Consent

Informed Consent for Online Survey

This consent form provides you 1) information on the study you are being asked to participate in and 2) how your confidentiality will be protected should you choose to participate in this study.

My name is Andrew Grandage and I am conducting this survey as part of my dissertation research at The University of Georgia, Department of Public Administration and Policy, in Athens, Georgia.

This survey will collect information on your professional background, project management office, project management guidelines, and the use of Earned Value Management (EVM). The information on your professional background is collected to understand the composition of the participants of the study and is NOT intended to be linked to you. The survey should take no longer than 30 minutes of time to complete.

The primary goals of this study are 1) to develop and disseminate knowledge of project management practices in state governments for IT, and 2) to better prepare students of public management for careers in project management.

You are assured complete confidentiality in participating in this survey. None of this information will be linked to you individually in any way.

Your participation in this survey is completely voluntary. You may elect to quit the survey at any time or skip any questions that you do not want to answer.

If you have any questions about this study, please contact me at 772-473-8736 or ajg85100@uga.edu. Alternatively, you may contact my Dissertation Chair, Dr. Katherine Willoughby, at 678-642-7248 or kwilloughby@uga.edu.

To consent to participate in the study, click "I AGREE to participate" below.

- ○ I AGREE to participate
- ○ I DECLINE to participate

Skip To: End of Survey If Informed Consent for Online Survey This consent form provides you 1) information on the study... = I DECLINE to participate

End of Block: Informed Consent

Start of Block: Professional Background

The first section of this survey gathers information on your professional background. This information is collected to understand the composition of the study participants and is not intended to be linked to you individually.

How many years have you worked in project management?

- ○ <5
- ○ 5-10
- ○ 11-15
- ○ 16-20
- ○ >20

How many years have you worked managing IT projects in state government?

- ○ <5
- ○ 5-10
- ○ 11-15
- ○ 16-20
- ○ >20

Are you a certified Project Management Professional (PMP)?

- ○ Yes
- ○ No

End of Block: Professional Background

Start of Block: Project Management Office

The next section of this survey gathers background information on your Project Management Office.

Please list your state government:

_____

How many years has your state operated a Project Management Office for IT?

- ○ <5
- ○ 5-10
- ○ 11-15
- ○ 16-20
- ○ >20
- ○ We do not operate a Project Management Office for IT

Skip To: End of Block If How many years has your state operated a Project Management Office for IT? = We do not operate a Project Management Office for IT

Which of the following best describes the staffing of your Project Management Office?

- ○ State employees
- ○ External consultants
- ○ State employees and external consultants

How many full-time employees work for your Project Management Office?

- ○ <5
- ○ 5-10
- ○ 11-15
- ○ 16-20
- ○ >20

Does your office provide consulting services to agencies?

- ○ Yes
- ○ No

Skip To: Q7 If Does your office provide consulting services to agencies? = Yes

---

Page Break

Are there plans to offer consulting services in the future?

- ○ Yes
- ○ No

Display This Question:

If Does your office provide consulting services to agencies? = Yes

What type of consulting services does your office provide to agencies? Select all that apply.

- ☐ Requirements
- ☐ Contracting
- ☐ Scheduling
- ☐ Budgeting
- ☐ Risk
- ☐ Quality
- ☐ Organizational Change
- ☐ Process Improvement
- ☐ Other, please specify: _____

End of Block: Project Management Office

Start of Block: Project Management Guidelines

The next section of this survey gathers information on your project management guidelines.

What sources of practice guidance have been used in developing your project management guidelines? Select all that apply.

- ☐ Project Management Institute
- ☐ U.S. federal agencies
- ☐ Other state governments
- ☐ Other, please specify: _____

How many years has your office had defined project management guidelines?

- ○ <5
- ○ 5-10
- ○ 11-15
- ○ 16-20
- ○ >20
- ○ Our office does not have defined project management guidelines

Skip To: End of Block If How many years has your office had defined project management guidelines? = Our office does not have defined project management guidelines

Which of the following best describes the application of the project management guidelines?

- ○ Agencies must use the guidelines in managing their major IT projects
- ○ Agencies can use the guidelines if they choose, but can develop their own guidelines for managing their major IT projects

End of Block: Project Management Guidelines

Start of Block: Earned Value Management

This section of the survey gathers information on use of Earned Value Management in your office.

Does your office currently recommend use of Earned Value Management (EVM)?

- ○ Yes
- ○ No

Skip To: Q31 If Does your office currently recommend use of Earned Value Management (EVM)? = Yes

Are there plans to recommend use of EVM in the future?

- ○ Yes
- ○ No

Skip To: Q30 If Are there plans to recommend use of EVM in the future? = No
Skip To: Q86 If Are there plans to recommend use of EVM in the future? = Yes

How many years has your office recommended use of EVM?

- ○ <3
- ○ 3-5
- ○ 6-10
- ○ 11-15
- ○ 16-20
- ○ >20

Does your office provide criteria to agencies to determine when to use EVM?

- ○ Yes
- ○ No

Skip To: Q34 If Does your office provide criteria to agencies to determine when to use EVM? = No

---

What criteria are considered to determine when to use EVM? Select all that apply.

- ☐ Cost
- ☐ Duration
- ☐ Risk
- ☐ Contract type
- ☐ Other, please specify: _____

What best describes your office's current strategy for EVM?

- ○ We are developing a common set of procedures for use across all projects
- ○ We are tailoring procedures according to project size, risk, or complexity

Has your office considered using U.S. federal EVM guidelines as a basis to develop practice guidance?

- ○ Yes
- ○ No

Skip To: Q36 If Has your office considered using U.S. federal EVM guidelines as a basis to develop practice guida... = No

Did any of these factors contribute to your decision to use federal guidelines? Select all that apply.

- ☐ To use a strong policy standard
- ☐ To provide clear criteria for the application of EVM
- ☐ To conduct independent reviews of the performance baseline prior to beginning major projects
- ☐ To link EVM indicators with corrective action plans
- ☐ To define criteria for revising baselines
- ☐ To develop training programs
- ☐ Other, please specify: _____

Display This Question:

If Has your office considered using U.S. federal EVM guidelines as a basis to develop practice guida... = No

Did any of these factors contribute to your decision to not use federal guidelines? Select all that apply.

- ☐ Not cost-effective to implement
- ☐ Unnecessarily complex
- ☐ Our current system works fine
- ☐ Contractors lack experience with federal guidelines
- ☐ Other, please specify: _____

Did any of these factors contribute to your office recommending EVM?

Select all that apply.

- ☐ Use of EVM by the federal government
- ☐ Use of EVM by other state governments
- ☐ Use of EVM by agencies in this state
- ☐ Recommendation of external consultants
- ☐ Other, please specify: _____

Display This Question:

If Are there plans to recommend use of EVM in the future? = No

What are the reasons for not recommending use of EVM? Select all that apply.

- ☐ Not suitable for information technology projects
- ☐ Not cost-effective to implement for our projects
- ☐ Contractor inexperience with EVM
- ☐ EVM pilot failed to show value
- ☐ Our office does not provide such recommendations
- ☐ Other, please specify: _____

Which of the following best describes use of EVM for major IT projects in your state?

- ○ EVM is not used
- ○ EVM is used, but not on the majority of projects
- ○ EVM is used for the majority of projects
- ○ EVM is used for all projects
- ○ Other, please specify: _____

Based on your experiences in state government managing IT projects, indicate your perception regarding potential contributions to project management from EVM:

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
EVM is an effective early warning system for cost overruns	○	○	○	○	○
EVM is an effective early warning system for schedule delays	○	○	○	○	○
EVM helps prevent scope creep	○	○	○	○	○
EVM helps achieve cost objectives	○	○	○	○	○
EVM helps achieve schedule objectives	○	○	○	○	○
EVM indicators are effective in communicating project status in portfolio management	○	○	○	○	○
EVM helps facilitate corrective action	○	○	○	○	○
Overall, EVM is an effective performance management tool	○	○	○	○	○

Based on your experiences in state government managing IT projects, indicate your perception of the potential importance of the following factors to successful EVM implementation.

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Establishment of a centralized project management office	○	○	○	○	○
Adoption of EVM industry standards	○	○	○	○	○
Tailoring of EVM procedures for project context	○	○	○	○	○
Project Management Professionals (PMP)	○	○	○	○	○
EVM training programs	○	○	○	○	○
Contractor experience with EVM	○	○	○	○	○
Independent reviews of the performance baseline	○	○	○	○	○
Development of corrective action plans based on EVM indicators	○	○	○	○	○

End of Block: Earned Value Management

Start of Block: Open-Ended Questions

The final section of this survey asks a couple open-ended questions.

How can enterprise project management offices improve the budgeting and financial management practices of agencies? Can you provide an example of your office providing support that has been effective in this regard?

_____

_____

_____

_____

_____

Based on your experiences in state government, can you provide an example of a case where EVM helped a project team achieve its technical, schedule, or cost objectives?

_____

_____

_____

_____

_____

Please indicate below if I can contact you regarding follow-up questions about your project management office and activities.

- ○ Yes
- ○ No

End of Block: Open-Ended Questions

APPENDIX C

STATE DOT SURVEY

State DoT Survey

Start of Block: Informed Consent

Informed Consent for Online Survey

This consent form provides you 1) information on the study you are being asked to participate in and 2) how your confidentiality will be protected should you choose to participate in the study.

My name is Andrew Grandage. I am conducting this survey as part of my dissertation research at The University of Georgia, Department of Public Administration and Policy, in Athens, Georgia.

This survey will collect information on your professional background, state Department of Transportation, project management guidelines, and the use of Earned Value Management. The information on your professional background is collected to understand the composition of the participants of the study and is NOT intended to be linked to you. The survey should take no longer than 30 minutes of time to complete.

The primary goals of this study are 1) to develop and disseminate knowledge of project management practices in state governments for transportation, and 2) to better prepare students of public management for careers in project management.

You are assured complete confidentiality in participating in this survey. None of this information will be linked to you individually in any way.

Your participation in this survey is completely voluntary. You may elect to quit the survey at any time or skip any questions that you do not want to answer.

If you have any questions about this study, please contact me at 772-473-8736 or ajg85100@uga.edu. Alternatively, you may contact my Dissertation Chair, Dr. Katherine Willoughby, at 678-642-7248 or kwilloughby@uga.edu.

To consent to participate in the study, click "I AGREE to participate" below. ○ I AGREE to participate ○ I DECLINE to participate

Skip To: End of Survey If Informed Consent for Online Survey This consent form provides you 1) information on the study... = I DECLINE to participate

End of Block: Informed Consent

Start of Block: Professional Background

The first section of this survey gathers information on your professional background. This information is collected to understand the composition of the study participants and is not intended to be linked to you individually.

How many years have you worked in project management?

- ○ <5
- ○ 5-10
- ○ 11-15
- ○ 16-20
- ○ >20

How many years have you worked managing transportation projects in state government?

- ○ <5
- ○ 5-10

- ○ 11-15
- ○ 16-20
- ○ >20

Please indicate if you have any of these certifications. Select all that apply:

- ☐ Project Management Professional (PMP)
- ☐ Professional Engineer (PE)
- ☐ Other, please specify: _____

End of Block: Professional Background

Start of Block: State Department of Transportation

The next section of this survey gathers background information on your state Department of Transportation.

Please list your state government

_____

Does your state Department of Transportation (DoT) have a Project Management Office (PMO)?

- ○ Yes
- ○ No

Skip To: End of Block If Does your state Department of Transportation (DoT) have a Project Management Office (PMO)? = No

Which of these best describe the PMOs your state DoT has? Select all that apply.

- ☐ We have a statewide office
- ☐ We have regional offices
- ☐ We have offices for different types of transportation projects
- ☐ Other, please specify:

_____

Display This Question:

If Which of these best describe the PMOs your state DoT has? Select all that apply. = We have a statewide office

How many years has your DoT had a statewide PMO?

<5 ○ 5-10 ○ 11-15 ○ 16-20 ○ >20 ○ I am not sure

Do any of your PMOs provide consulting services to project teams?

○ Yes

○ No

Skip To: Q7 If Do any of your PMOs provide consulting services to project teams? = Yes

Are there plans to offer consulting services in the future?

○ Yes

○ No

Display This Question:
If Do any of your PMOs provide consulting services to project teams? = Yes

What type of consulting services do your PMOs provide to project teams? Select all that apply.

☐ Requirements

☐ Contracting

- [ ] Scheduling
- [ ] Budgeting
- [ ] Risk
- [ ] Quality
- [ ] Organizational Change
- [ ] Process Improvement
- [ ] Other, please specify: _____

End of Block: State Department of Transportation

Start of Block: Project Management Guidelines

The next section of this survey gathers information on your project management guidelines.

What sources of practice guidance have been used in developing your project management guidelines? Select all that apply.

- [ ] Project Management Institute
- [ ] U.S. Department of Transportation
- [ ] American Association of State Highway and Transportation Officials
- [ ] Other state governments

☐ Other, please specify:

_____

How many years has your DoT had defined project management guidelines?

○ <5 ○ 5-10 ○ 11-15 ○ 16-20 ○ >20 ○ Our DoT does not have defined project management guidelines

Skip To: End of Block If How many years has your DoT had defined project management guidelines? = Our DoT does not have defined project management guidelines

Which of the following best describes the application of the project management guidelines for major projects?

○ Project teams must use the guidelines in managing their major projects

○ Project teams can use the guidelines if they choose, but can develop their own guidelines for managing their major projects

End of Block: Project Management Guidelines

Start of Block: Earned Value Management

This section of the survey gathers information on use of Earned Value Management in your DoT.

Does your DoT currently recommend use of Earned Value Management (EVM)?

○ Yes

○ No

Skip To: Q31 If Does your DoT currently recommend use of Earned Value Management (EVM)? = Yes

Are there plans to recommend use of EVM in the future?

- ○ Yes
- ○ No

Skip To: Q30 If Are there plans to recommend use of EVM in the future? = No
Skip To: Q86 If Are there plans to recommend use of EVM in the future? = Yes

How many years has your DoT recommended use of EVM?

- ○ <3
- ○ 3-5
- ○ 6-10
- ○ 11-15
- ○ 16-20
- ○ >20

Does your DoT provide criteria to project teams to determine when to use EVM?

- ○ Yes
- ○ No

Skip To: Q34 If Does your DoT provide criteria to project teams to determine when to use EVM? = No

What criteria are considered to determine when to use EVM? Select all that apply.

- [ ] Cost
- [ ] Duration
- [ ] Risk
- [ ] Contract type
- [ ] Other, please specify:

_____

What best describes your DoT's current strategy for EVM?

- ○ We are developing a common set of procedures for use across all projects
- ○ We are tailoring procedures according to project size, risk, or complexity

Has your DoT considered using U.S. federal EVM guidelines as a basis to develop practice guidance?

- ○ Yes
- ○ No

Skip To: Q36 If Has your DoT considered using U.S. federal EVM guidelines as a basis to develop practice guidance? = No

Did any of these factors contribute to your decision to use federal guidelines? Select all that apply.

☐ To use a strong policy standard

☐ To provide clear criteria for the application of EVM

☐ To conduct independent reviews of the performance baseline prior to beginning major projects

☐ To link EVM indicators with corrective action plans

☐ To define criteria for revising baselines

☐ To develop training programs

☐ Other, please specify:

_____

Display This Question:

If Has your DoT considered using U.S. federal EVM guidelines as a basis to develop practice guidance? = No

Did any of these factors contribute to your decision to not use federal guidelines? Select all that apply.

- ☐ Not cost-effective to implement
- ☐ Unnecessarily complex
- ☐ Our current system works fine
- ☐ Contractors lack experience with federal guidelines
- ☐ Other, please specify: _____

Did any of these factors contribute to your DoT recommending EVM? Select all that apply.

- ☐ Use of EVM by the federal government
- ☐ Use of EVM by other state governments
- ☐ Use of EVM by agencies in this state
- ☐ Recommendation of external consultants

☐ Other, please specify:

_____

Display This Question:

If Are there plans to recommend use of EVM in the future? = No

What are the reasons for not recommending use of EVM? Select all that apply.

☐ Not suitable for transportation projects

☐ Not cost-effective to implement for our projects

☐ Contractor inexperience with EVM

☐ EVM pilot failed to show value

☐ Our office does not provide such recommendations

☐ Other, please specify:

_____

Which of the following best describes use of EVM for major transportation projects in your state?

○ EVM is not used

○ EVM is used, but not on the majority of projects

○ EVM is used for the majority of projects

- ○ EVM is used for all projects

- ○ Other, please specify: _____

Based on your experiences in state government managing transportation projects, indicate your perception regarding potential contributions to project management from EVM:

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
EVM is an effective early warning system for cost overruns	○	○	○	○	○
EVM is an effective early warning system for schedule delays	○	○	○	○	○
EVM helps prevent scope creep	○	○	○	○	○
EVM helps achieve cost objectives	○	○	○	○	○
EVM helps achieve schedule objectives	○	○	○	○	○
EVM indicators are effective in communicating project status in portfolio management	○	○	○	○	○

EVM helps facilitate corrective action	○	○	○	○	○
Overall, EVM is an effective performance management tool	○	○	○	○	○

Based on your experiences in state government managing transportation projects, indicate your perception of the potential importance of the following factors to successful EVM implementation.

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Establishment of a centralized project management office	○	○	○	○	○
Adoption of EVM industry standards	○	○	○	○	○
Tailoring of EVM procedures for project context	○	○	○	○	○
Project Management Professionals (PMP)	○	○	○	○	○
EVM training programs	○	○	○	○	○
Contractor experience with EVM	○	○	○	○	○

Independent reviews of the performance baseline	○	○	○	○	○
Development of corrective action plans based on EVM indicators	○	○	○	○	○

End of Block: Earned Value Management

Start of Block: Open-Ended Questions

The final section of this survey asks an open-ended question.

How can state DoTs improve the budgeting and financial management practices used for major transportation projects? Can you provide an example of your DoT providing support that has been effective in this regard?

_____

_____

_____

_____

_____

Please indicate below if I can contact you regarding follow-up questions about your project management office and activities.

○ Yes ○ No