GEORGIA DOT RESEARCH PROJECT 22-25

FINAL REPORT

A PLAYBOOK FOR CM/GC ADOPTION IN TRANSPORTATION PROJECTS

OFFICE OF PERFORMANCE-BASED MANAGEMENT AND RESEARCH

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16. Abstract
The Construction Manager/General Contractor (CM/GC) project delivery method is gaining widespread adoption in the transportation sector due to its ability to integrate construction expertise early in the project lifecycle. This report serves as a playbook for CM/GC adoption in transportation projects, specifically tailored for the Georgia Department of Transportation (GDOT). The study examines CM/GC best practices from multiple Department of Transportation (DOT) agencies across the United States, evaluates their effectiveness, and identifies opportunities for GDOT to enhance its implementation strategy. The research is conducted through a comprehensive methodology that includes an extensive literature review, case study analysis, and a Delphi survey to consolidate expert opinions on best practices. Case studies from Utah, California, Colorado, Oregon, Minnesota, Tennessee, and Michigan highlight key strategies in CM/GC project identification, procurement, preconstruction services, and cost negotiation mechanisms. A comparative analysis between GDOT's existing framework and those of other DOTs reveals areas for improvement, including refinements in selection and procurement approaches, risk-sharing models, constructability reviews, and execution efficiencies. Findings indicate that early contractor involvement, progressive Guaranteed Maximum Price (GMP) structures, risk-based pricing models, and digital collaboration tools significantly enhance project delivery outcomes. The report concludes with actionable policy recommendations for GDOT to optimize CM/GC implementation, including enhanced procurement evaluation criteria, structured contractor collaboration processes, and integration of emerging digital technologies. These recommendations aim to streamline project execution, mitigate risks, and improve cost control, ensuring that GDOT achieves greater efficiency, transparency, and innovation in its transportation infrastructure projects.

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Final Report

A PLAYBOOK FOR CM/GC ADOPTION IN TRANSPORTATION PROJECTS

By

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BOARD OF REGENTS OF THE UNIVERSITY SYSTEM OF GEORGIA
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Federal Highway Administration

May 2025

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000 L shall be shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

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LIST OF ABBREVIATIONS

ABC	Accelerated Bridge Construction
ACM	Alternative contracting method
AGC	Associated General Contractors
AI	Artificial Intelligence
ASCE	American Society of Civil Engineers
BV	Best Value
CALTRANS	California Department of Transportation
CDOT	Colorado Department of Transportation
CMAA	Construction Management Association of America
CMAR	Construction Manager at Risk
CM/GC	Construction Manager/General Contractor
CMR	Construction Manager at Risk
DB	Design-Build
DBB	Design-Bid-Build
DBE	Disadvantaged Business Enterprises
DBIA	Design-Build Institute of America
DCR	Depth Of Constructability Reviews

DOT	Department of Transportation
ECI	Early Contractor Involvement
EE	Execution Efficiencies
FHWA	Federal Highway Administration
GCCM	General Contractor-Construction Manager
GDOT	Georgia Department of Transportation
GMP	Guaranteed Maximum Price
IAMP	Interchange Area Management Plan
ICE	Independent Cost Estimator
KPI	Key Performance Indicators
MDOT	Michigan Department of Transportation
MNDOT	Minnesota Department of Transportation
NCHRP	National Cooperative Highway Research Program
NCP	Negotiated Construction Pricing
NEPA	National Environmental Policy Act
NS	Norfolk Southern
ODOT	Oregon Department of Transportation
OPCC	Opinion of Probable Construction Cost estimates
PDSM	Project Delivery Selection Matrix
QA/QC	Quality Assurance/Quality Control
QBS	Qualifications-Based Selection
RFI	Request For Information
RFP	Request For Proposal
RFQ	Request for Qualification
R&P	Risk Allocation and Pricing Mechanisms
SOQ	Statement Of Qualification
S&P	Selection and Procurement
TDOT	Tennessee Department of Transportation
TEA	Transportation Equity Act
UDOT	Utah Department of Transportation
US	United States
USA	United States of America

1. INTRODUCTION

The Georgia Department of Transportation (GDOT) managers, engineers, and its contractors have been for a long time accustomed to the Design Bid Build (DBB), and lately the Design-Build (DB) project delivery approaches. However, traditional project delivery methods such as Design-Bid-Build (DBB) often face challenges in cost overruns, schedule delays, and inefficient risk allocation, especially when transportation infrastructure projects are becoming increasingly complex due to growing urban populations, aging roadways, and rising construction costs. To address these issues, state transportation agencies have begun exploring alternative project delivery methods that foster early contractor involvement, improve constructability, and enhance cost predictability. Among these, the Construction Manager/General Contractor (CM/GC) method has emerged as a viable and effective approach. The CM/GC method allows for early collaboration between project owners, designers, and contractors during the preconstruction phase, enabling a more informed decision-making process. Unlike DBB, where the contractor is selected after design completion, CM/GC integrates the contractor's expertise at an earlier stage, resulting in optimized risk management, improved cost estimation, and reduced schedule uncertainty.

However, for the first time, GDOT is planning to deploy CM/GC project delivery and contracting approach for the procurement and management of their construction projects. The effectiveness of CM/GC depends on strategic implementation, well-defined procurement processes, and structured collaboration mechanisms. To facilitate GDOT's transition to implementing CM/GC, the importance of educating the project team on subtle nuances of CM/GC, code of conduct, collaborative behavior, responsibilities, organizational structure, and communication procedures are also discussed in that meeting.

Consequently, the objective of this research is to develop a comprehensive playbook for CM/GC adoption in transportation projects, with a specific focus on GDOT's implementation strategy. This study evaluates existing CM/GC frameworks in other state DOTs, identifies best practices, and provides recommendations for enhancing GDOT's approach. By conducting a comparative analysis of successful case studies and engaging industry experts through a Delphi survey, this report offers data-driven insights to streamline GDOT's CM/GC execution, mitigate project risks, and improve overall efficiency.

2. GOALS AND OBJECTIVES

The primary goal of this study is to develop a structured framework for GDOT to effectively adopt and implement CM/GC project delivery in its transportation infrastructure projects. To achieve this, the study is guided by the following key objectives. By achieving these objectives, this study will provide GDOT with actionable insights and strategies to enhance the effectiveness, transparency, and efficiency of its CM/GC program, ultimately leading to improved transportation infrastructure delivery across the state.

Objectives (denoted with "✓") and specific steps (denoted with "•")

- ✓ Evaluate Existing CM/GC Best Practices
  - Conduct a literature review to understand the evolution and application of CM/GC.
  - Examine case studies from other DOTs to identify success factors, challenges, and implementation strategies.
- ✓ Compare GDOT's Current CM/GC Framework with Other DOTs
  - Perform a comparative analysis to highlight alignment gaps and opportunities for GDOT.
  - Assess selection and procurement strategies, risk allocation mechanisms, constructability review processes, and execution efficiency used in different states.
- ✓ Identify and Develop Key CM/GC Best Practices for GDOT
  - Categorize best practices in four core areas based on GDOT CM/GC manual structure:
    1) Project Identification & Selection
    2) Procurement & Contractor Selection
    3) Preconstruction Services & Risk Management
    4) Cost Control & Negotiated Construction Pricing (NCP)
  - Identify emerging technologies (e.g., AI-driven cost estimation, digital twins, and automated constructability reviews) that could enhance CM/GC efficiency.
- ✓ Conduct a Delphi Survey for Expert Consensus
  - Engage industry experts, contractors, DOT officials, and consultants to refine and validate CM/GC best practices.
  - Use iterative feedback to prioritize strategies most applicable to GDOT.
- ✓ Develop an Implementation Strategy for GDOT
  - Provide a step-by-step roadmap for integrating CM/GC best practices into GDOT projects.
  - Offer policy recommendations, procurement guidelines, and training initiatives to enhance GDOT's ability to manage CM/GC projects successfully.
- ✓ Recommend Policy and Procedural Enhancements
  - Suggest modifications to GDOT's contract structures, risk-sharing models, and incentive mechanisms.
  - Align GDOT's policies with other DOT's best practices and industry standards to ensure consistency and efficiency in CM/GC project execution.

3. TASK REVIEW

Here is a table summarizing the task details and expected outcomes, in terms of each task's expected outcomes.

Table 1. Task details and expected outcomes

Task Details	***Expected Outcomes***
Task 1: Conduct a literature review to identify the procurement, contracting, and execution best practices for CM/GC approach for transportation projects, and to highlight the unique traits and differences of CM/GC approach compared to other delivery methods (e.g., DBB & DB). The process involves the review of the body of knowledge, identification and extraction of best practices, synthesis of identified practices, analysis and clustering of practices, finalization and identification of the relatively prominent best practices.	Outcome 1: Literature review results including a comprehensive list of CM/GC Best Practices.
Task 2: Do a scan of other DOTs who have adopted CM/GC, and capture their best procurement, contracting, execution practices, as well as their lessons learned. I will identify the DOTs who have implemented CM/GC in projects and conduct a survey and/or a virtual roundtable discussion to capture their best practices and lessons learned on their CM/GC projects.	Outcome 2: DOT-specific best practices for CM/GC and lessons learned recommendations.
Task 3: Conduct a Delphi Survey or an expert interview with GDOT to finalize the essential procurement, contracting, and execution best practices for transportation projects. I will consolidate the best practices identified through literature review, survey and round-table discussions and develop an interview questionnaire or a Delphi survey. To finalize the best practices, statistical methods will be used for defining consensus for Delphi survey results.	Outcome 3: Finalized list of GDOT-complied best practices for CM/GC.
Task 4: Develop the final report, an interactive educational playbook, and a brief training video to educate future project players on the nuances of CM/GC implementation and best practices. The playbook will highlight the distinguishing characteristics of CM/GC and presents its best practices. The training video will do accomplish the same mission through audio and visual means. Both the playbook and the video will facilitate GDOT's successful adoption of CM/GC.	Outcome 4: A final research report including all research outcomes. Outcome 5: An interactive educational playbook: Unique traits of CM/GC & best practices. Outcome 6: A training video on CM/GC nuances.

4. RESEARCH METHODOLOGY

This section outlines the comprehensive methods used to assess the efficacy of the CM/GC method compared to traditional project delivery systems such as Design-Bid-Build (DBB) and Design-Build (DB). To ensure a robust and well-rounded analysis, the study employs a multi-method approach, integrating literature review, case study analysis, expert Delphi survey, and comparative analysis techniques. This structured methodology enables the identification of best practices, key challenges, and strategic recommendations for the adoption of CM/GC in transportation projects.

4.1 Literature Review

The literature review establishes a strong theoretical foundation for understanding the evolution, application, and impact of the CM/GC method. It synthesizes academic research, industry reports, and case studies to extract best practices and performance insights.

Scope of Review

The literature review covers a broad range of sources to ensure a comprehensive understanding of CM/GC's current application, including:

- ✓ Academic Journals: Peer-reviewed articles from construction management, engineering, and project management disciplines that discuss methodologies, research findings, and case studies related to CM/GC. For example, several articles from Journal of the Transportation Research Board (Transportation Research Record), Journal of Management in Engineering (ASCE library), Journal of Construction Engineering and Management (ASCE library), as well as Engineering, Construction and Architectural Management (Emerald Insight) are included in the literature review.
- ✓ Industry Reports: Publications from leading professional associations such as the Construction Management Association of America (CMAA), the Design-Build Institute of America (DBIA), National Cooperative Highway Research Program (NCHRP), Federal Highway Administration (FHWA) are included in the literature review, focusing on trends, best practices, procurement models, and regulatory frameworks.
- ✓ Case studies: details analysis of completed and ongoing projects using the CM/GC method, particularly those funded by state Departments of Transportation (DOTs), to identify real-world applications and outcomes. DOTs from Utah, California, Colorado, Oregon, Minnesota, Tennessee, and Michigan are selected in this study.

Literature Review Process

- ➢ Selection of Relevant Studies: Identifying key publications, state DOT manuals, and academic research related to CM/GC.
- ➢ Extraction of Best Practices: Evaluating procurement methods, contractor engagement models, risk-sharing mechanisms, and cost-control strategies.
- ➢ Comparative Analysis: Examining differences of CM/GC practices in terms of Project Identification & Selection, Procurement & Contractor Selection, Preconstruction Services & Risk Management, and Cost Control & Negotiated Construction Pricing (NCP).
- ➢ Synthesis of Findings: Developing a structured summary of CM/GC best practices, limitations, and implementation considerations.

4.2 Comparative Analysis of Case Studies

To complement the literature review, the study integrates primary data collection through case studies and a Delphi survey of industry experts. Case studies from seven DOTs (UDOT, Caltrans, CDOT, ODOT, MnDOT, TDOT, and MDOT) provide practical insights into CM/GC implementation strategies. These cases are analyzed to evaluate:

- ✓ Project Identification and Procurement Methods: How DOTs determine CM/GC suitability and selection criteria for contractors and integration of best-value approaches.
- ✓ Risk Allocation & Cost Control: Utilization of Guaranteed Maximum Price (GMP), progressive pricing models, and independent cost estimators.
- ✓ Preconstruction and Constructability Reviews: Extent of early contractor involvement and constructability assessments.
- ✓ Execution Efficiency: Project cost, schedule performance, and stakeholder satisfaction.

Each case study is assessed based on alignment with GDOT's goals, policy frameworks, and identified best practices.

4.3 Delphi Survey

A Delphi survey is conducted to refine and validate CM/GC best practices through expert consensus. This method is particularly effective for:

- Building expert-driven insights in areas with evolving industry practices.
- Identifying gaps in GDOT's CM/GC implementation framework.
- Refining risk-sharing models, procurement structures, and contract incentives.

The Delphi process includes:

- ➢ Expert Selection: Involvement of DOT officials, construction managers, consultants, and procurement specialists.
- ➢ Survey Process: Open-ended and 5-point Likert-scale questions on key CM/GC best practices.
- ➢ Data Analysis & Refinement: Identification of high-consensus practices for further validation.
- ➢ Consensus & Recommendations: Practices with 70% or higher agreement are categorized as GDOT-specific recommendations.

5. LITERATURE REVIEW FINDINGS

In recent decades, the construction industry has witnessed the emergence of new and innovative project delivery methods designed to enhance project performance. These methods have been gaining popularity over traditional approaches by offering significant schedule and quality benefits through the integration of design and construction phases (Abkarian et al., 2017; Papajohn et al., 2019). Among these, the Construction Manager at Risk (CMAR) stands out. This method involves early engagement of the contractor to provide constructability input, cost and schedule analyses of design decisions, and reduce the likelihood of risk occurrences, thereby increasing the probability of positive project outcomes. Traditional delivery methods, which use the low bid option to procure the contractor, are often associated with project performance failure, due to the competitive nature of the bidding process (Carpenter & Bausman, 2016). However, this issue can be avoided in alternative delivery methods like CMAR, particularly because it may not always be appropriate to compete based on the lowest bid, given that the design is not yet complete, typically between 30-60% for CMAR (Francom et al., 2016). As a result, the procurement process for CMAR firms has been specifically designed to select the most qualified firm capable of successfully executing the project. It should be noted that the contractor's procurement method not only impacts the project delivery method but also affects the project outcome (Kenig, 2011).

5.1 Evolution of Alternative Contracting or Project Delivery Methods

Here is an image demonstrating the development of CM/GC from 1987 to 2017 (see Figure 1). This image outlines a historical timeline of key legislative and regulatory milestones that have shaped the adoption and implementation of innovative contracting methods in the United States, particularly focusing on DB and CM/GC approaches. Starting in 1987, Florida was authorized to conduct experiments with DB, setting a precedent for other states. This was then followed by the Transportation Research Board's Task on Innovative Contracting Practices in 1988. By 1990, the Special Experimental Project No. 14 (SEP-14) encouraged states to test innovative contracting methods like DB and CM/GC. Over the decades, several significant acts and regulations have been enacted, such as the Clinger-Cohen Act of 1996, which allowed DB to be used by federal agencies, and the Transportation Equity Act for the 21st Century (TEA-21) in 1998, which identified crucial development areas for DB implementation. More recent developments include the Federal Regulation in 2017 (Federal Regulation CM/GC Contracting Final Rule 23CFR630 & 635)(Federal Highway Administration, 2015), which explicitly permitted CM/GC contracting. This timeline demonstrates the progressive embrace of flexible and efficient project delivery methods in the public sector, fostering improved project outcomes and innovations in contracting.

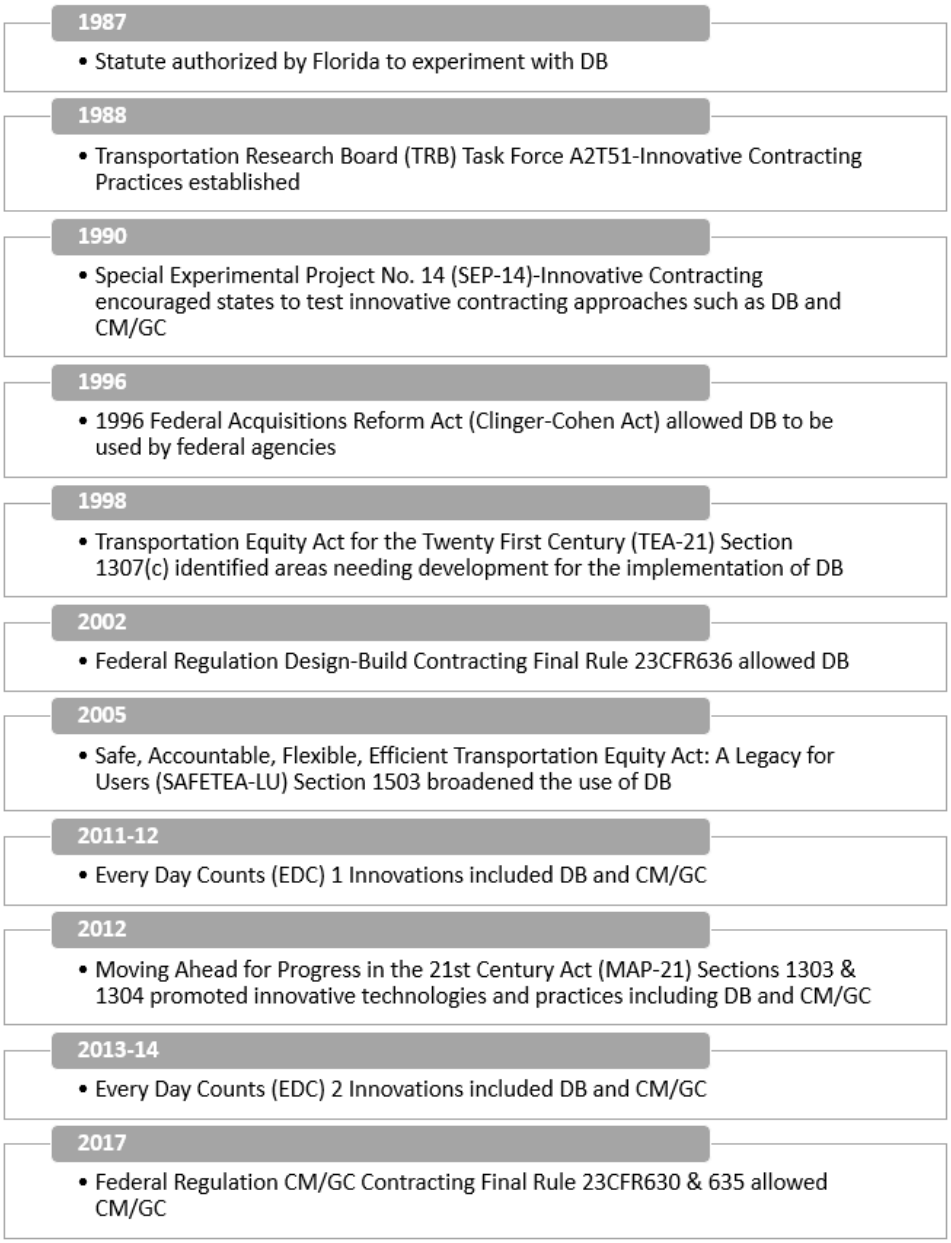

Figure 1. Evolution Of ACM legislation (Papajohn et al., 2019)

5.2 Terminologies and Contract Structure of CM/GC

- Construction Manager-at-Risk (CMAR, CMR, CM@R): CMAR involves the construction manager acting as an agent for the owner, taking a proactive role in the design and construction phases to manage cost and risks. The manager bids a lump sum and subcontracts all work, bearing the cost risks associated with the project. This is typical in vertical projects where the construction manager does not perform any work directly.
- Construction Manager/General Contractor (CM/GC): In this method, the construction manager is engaged during the preconstruction phase and transitions to a general contractor during the construction phase. Unlike CMAR, in horizontal CM/GC projects, the

contractor may self-perform significant portions of the work. This methods is often used in projects requiring substantial integration of construction and design insights from inception. Legislation in states like Connecticut and Minnesota refers to CM/GC as the preferred terminology over CMR.

- General Contractor-Construction Manager (GCCM): Similar in practice to CM/GC, GCCM involves a contractor who managers the construction process but also takes part in the design and planning phases to ensure constructability and manage risks effectively.
- Owner Facilitated Design-Build: An unusual term used by the Maine DOT for expedited project delivery, which involves the owner playing a more significant role in the design and build phases to fast-track the process under special authorization (SEP-14).
- Early Contractor Involvement (ECI): Used in New Zealand and by the US Army Corps of Engineers, ECI involves the contractor early in the project to improve project delivery through proactive involvement in design and planning stages.
- Federal Highway Administration (FHWA) Decisions and Legislation:
    - SEP-14 (Special Experimental Project No.14 – Alternative Contracting): An FHWA initiative that allows state DOTs to experiment with non-traditional contracting methods, determining their suitability for broader application.
    - MAP-21 (Moving Ahead for Progress in the 21st Century Act): As of October 1st, 2012, CMAR is recognized by FHWA as an approved delivery method, no longer requiring SEP-14 experimental status, reflecting its acceptance and integration into mainstream project delivery practices.

The following diagram created by Gransberg (2014) illustrates the organizational structure and relationships between various parties in a CM/GC construction project. The Owner oversees the project, setting the framework for the roles of the Designer-of-Record and the Construction Manager, who also takes on the role of General Contractor during the construction phase. The Designer-of-Record is responsible for the overall design, coordinating with Design Subconsultants to ensure all aspects of the architectural and engineering work are aligned with the project's requirements. The Construction Manager engages with the Designer-of-Record through contractual coordination requirements to facilitate seamless integration of design and construction phases. During the Preconstruction phase, the Construction Manager prepares for the project by planning and coordinating, shifting into the General Contractor role during the construction phase to manage on-site activities and subcontracting with Trade Subcontractors to execute specialized components of the construction. This structural flow emphasizes the collaborative effort required to move a project efficiently and effectively from concept through completion.

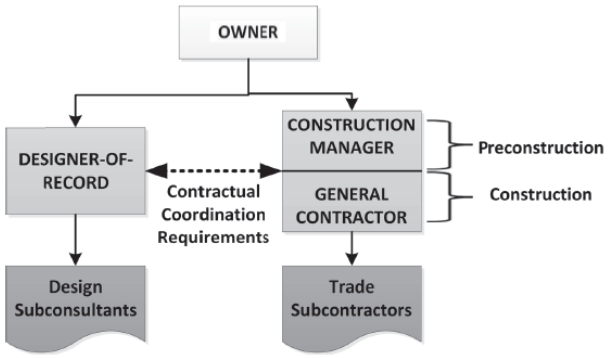

Figure 2. CM/GC Contract Structure (D. D. Gransberg, 2014)

5.3 Current State of CM/GC and Partnering Practices

At the federal level, CM/GC method is recognized by the Federal Highway Administration (FHWA) as part of its Every-Day Counts initiative, which promotes accelerated project delivery through innovative practices aimed at reducing costs and improving safety and environmental outcomes. Historically, the adoption of such innovative contracting methods was facilitated under the Special Experimental Projects No. 14 (SEP-14), which encouraged state Departments of Transportation (DOTs) to seek approval for projects employing alternative contracting methods (Adamtey & Kereri, 2019). However, with the enactment of the Moving Ahead for Progress in the 21st Century Act (MAP-21), the requirement for SEP-14 approval was removed for DOTs wishing to implement the CM/GC project delivery method. Currently, there are no specific FHWA regulations governing the use of CM/GC, reflecting a more streamlined approach to encouraging innovative project delivery strategies.

6. SUMMARIZATION OF BEST PRACTICES

In this section, the best practices from various CM/GC projects around the United States are summarized, demonstrated with summarization tables and tree diagrams. The structure is following GDOT CM/GC manual (GDOT, 2023) (see Table 2).

Table 2. Structure of GDOT CM/GC Manual

Chapter Number in GDOT CM/GC Manual	***Topic Name***
Chapter 2	CM/GC Project Identification and Selection
Chapter 3	CM/GC Project Procurements
Chapter 4	CM/GC Preconstruction Services
Chapter 5	Project Cost and Negotiated Construction Price (NCP)

6.1 Best Practices regarding CM/GC Project Identification and Selection

The selection of a suitable project delivery method is crucial for achieving efficiency and addressing specific project demands effectively. Within this context, the feasibility of CM/GC should be under discussion. According to the Oregon Public Contracting Coalition's Guide to CM/GC contracting (Gambatese et al., 2002), this approach yields significant benefits for projects

which are technically complex, constrained by tight schedules, require intricate phasing, or face strict budget limitations that necessitate a construction cost guarantee during the design phase. Additionally, projects that can benefit from value engineering to achieve considerable cost savings are ideal candidates for CM/GC (Gambatese et al., 2002; Shane & Gransberg, 2010, 2012)

In contrast, the Design-Build (DB) method is typically more advantageous for large-scale projects where right-of-way or utility risks are minimal. CM/GC, on the other hand, proves more beneficial for scenarios where such risks are present and where the Utah Department of Transportation (UDOT) seeks to control over design and select innovative solutions that might be outside a contractor's existing experience (Alder, 2008).

However, the Construction Manager at Risk (CMAR) method may not be the best fit for straightforward projects that are clearly defined and lack sensitive scheduling needs (D. D. Gransberg, 2014). Highlighting the strategic use of CMAR, Jane Lee from the Oregon DOT outlined key motivations during a 2008 presentation to the Western Association of State Highway and Transportation Officials. These motivations include enhanced collaboration and cost control, the ability to concurrently execute design and construction, suitability for complex projects with stringent timelines, alignment of project goals across all parties, effective risk management with ownership control, and a collaborative process that reduces the likelihood of disputes in construction and design (Shane & Gransberg, 2010). This nuanced understanding underlines that while CM/GC and CMAR offer substantial advantages under specific circumstances, the choice of project delivery method must align with the project's unique requirements and challenges to fully leverage the potential benefits.

Based on the nuances and specifics discussed above, several best practices are identified and recommended for ***identification and selection*** of appropriate project delivery methods. Here are a table and a tree diagram demonstrating the Best Practices, along with their descriptions and practical actions (see Table 3 and Figure 3).

Table 3. Summarization table of best practices identified through literature review for project identification and selection

Best Practice	***Description***	***Practical Actions***
Assessment of Project Complexity and Risk	Use detailed risk assessment tools and historical data analysis to identify the complexity level of the project.	Evaluate the technical specifications, potential environmental impacts, and legal considerations. Identify projects that have multi-faceted challenges requiring specialized knowledge or technology integration.
Alignment with Project Requirements	Review past project outcomes and current resource availability to ensure the selected method can meet the project's financial and scheduling goals.	Consider the project's timeline, budget constraints, and the technical demands. Check for requirements like cost guarantees during the design phase or the necessity for complex phasing.
Utilization of Early Contractor Involvement	Select project delivery methods that allow for contractor involvement from the earliest stages to leverage their insights, particularly for innovative solutions and risk management.	Determine the benefits of integrating the contractor's expertise during the preconstruction phase, especially for enhancing design efficiency and constructability.
Stakeholder Collaboration and Goal Alignment	Foster a collaborative environment through regular meetings, shared project	Identify the degree of required collaboration among the owner, architects, engineers, and contractors to achieve project goals.

	management tools, and clearly defined roles and responsibilities.	
Regulatory and Legislative Considerations	Maintain an updated knowledge base of regulatory changes and adapt project selection criteria accordingly to remain compliant while optimizing project outcomes.	Analyze current legislation and regulatory requirements that could impact project delivery method choices. Assess the need for compliance with federal initiatives like FHWA's Every-Day Counts or local state regulations.
Comprehensive Evaluation of Proposals	Develop a scoring system for Request For Proposals (RFPs) and Statement Of Qualifications (SOQs) that weighs critical factors appropriately.	Evaluate proposals based on not only the cost but also the qualitative factors such as contractor experience, past performance on similar projects, and the robustness of the technical approach.

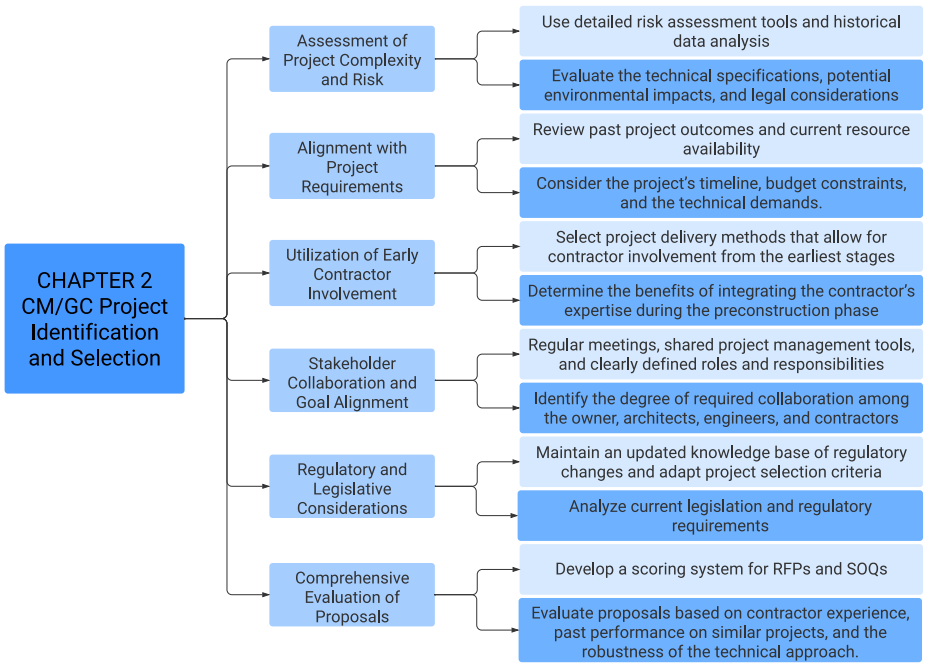

Figure 3. Tree diagram of best practices for project identification and selection

6.2 Best Practices regarding CM/GC Project Procurements

Procurement in construction projects is a critical component that involves acquiring the necessary resources, including property, designs, contracts, labor, materials, and equipment essential for project completion. Effective procurement strategies are vital to ensuring that projects adhere to their budgets, timelines, and quality standards. One of the key strategies involves the early selection of a Construction Manager as Constructor (CMR). Engaging the CMR during the preconstruction phase allows them to significantly influence design decisions, enhancing project value by optimizing design costs and efficiencies. This early involvement facilitates participation in design discussions before major decisions are finalized, leading to more accurate cost estimations and improved design quality (Schierholz, 2012; Shane & Gransberg, 2010).

Another best practice is the implementation of thorough verification procedures for evaluating a contractor's past performance and the qualifications of personnel. Educating all participants

involved in the CM-GC process about project specifics, procurement details, and negotiation strategies, especially concerning the Guaranteed Maximum Price (GMP), is also crucial. Additionally, utilizing Best Value (BV) procurement is recommended when designs are sufficiently developed to provide a clear scope of work. This procurement method incorporates cost components as part of the evaluation, allowing for a balanced consideration of price and performance capabilities, which is essential for a fair and transparent procurement process (D. D. Gransberg, 2014).

Further enhancing the procurement process, providing comprehensive training to the procurement evaluation committee is essential to ensure a fair selection process. Such training equips committee members with the necessary tools and knowledge to effectively assess proposals and implement best-value procurement. Maintaining transparency through detailed evaluation comments and thorough debriefings helps clarify the selection process, providing feedback to proposers on how to enhance their submissions for future contracts. Moreover, opting for Qualifications-Based Selection (QBS) over Best-Value Selection can be particularly beneficial. QBS focuses on the expertise and qualifications of the proposers, fostering innovation and effective risk management by allowing flexibility in the design process, rather than fixing prices too early, which might necessitate later adjustments (Alleman et al., 2017; Tran et al., 2017).

Building on the discussion of effective procurement strategies, the following diagram distinctly highlights three procurement processes that embody structured approaches to initiating construction projects, namely the One-Step Qualifications-Based Selection process, the One-Step Best Value Selection process, and the Two-Step BV Selection process (see Figure 4 and Figure 5). Each method is tailored to meet specific project needs, ensuring that the procurement phase aligns strategically with the overarching goals of project management, budget adherence, and timely completion. In the One-Step QBS process, the focus is on evaluating contractor qualifications upfront, followed by an assessment of qualifications, award of services, and the potential development of a Guaranteed Maximum Price (GMP) agreement, which might lead to a low-bid selection if the GMP is not attainable with Construction Manager (CM) involvement. The One-Step BV Selection process similarly begins with an RFP and moves through evaluation, best-value selection, and possibly GMP development, with outcomes depending on the feasibility of reaching a GMP agreement with the CM. The Two-Step BV process, more elaborate, starts with a Request for Qualifications (RFQ), followed by a shortlisting phase, RFP issuance, contractor proposal submission, and concludes with a best-value selection that also aims for a GMP agreement, leading to a low-bid selection if not feasible. Each method is designed to streamline project initiation while aligning with project-specific requirements and goals.

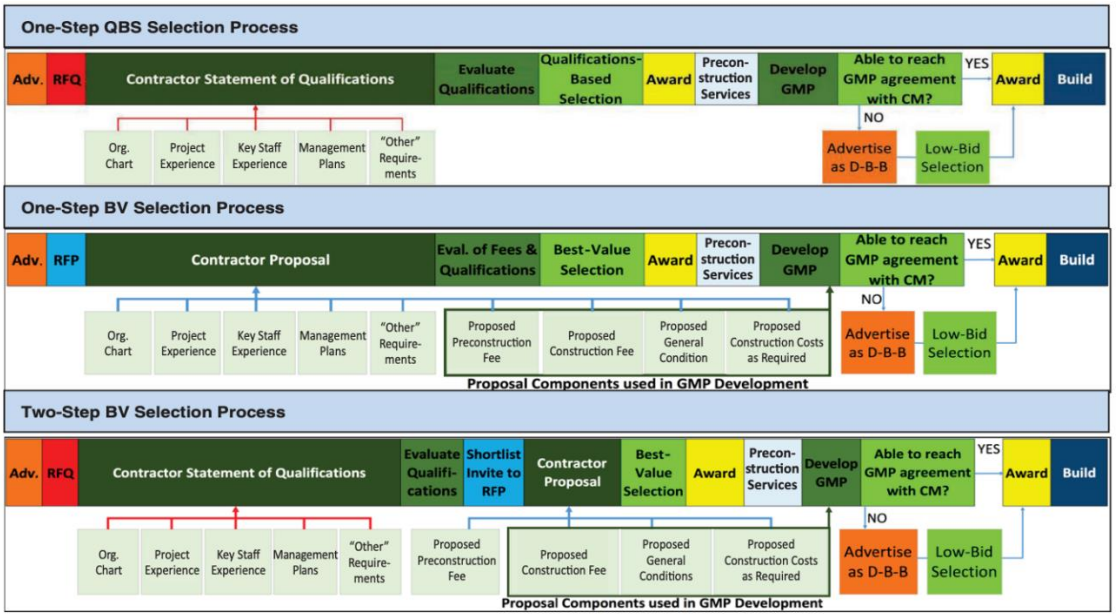

Figure 4. CM/GC selection process (Alleman et al., 2017)

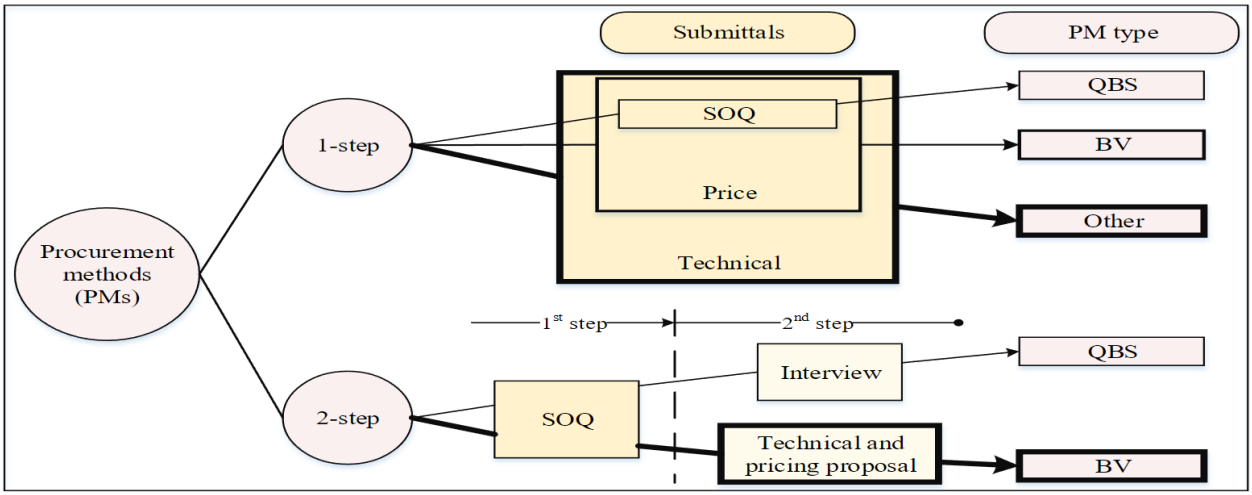

Figure 5. CM/GC Procurement method categorization (Sanboskani et al., 2022)

Based on the nuances and specifics discussed above, several best practices are identified and recommended for ***project procurement*** of appropriate project delivery methods. Here are a table and a tree diagram demonstrating the Best Practices, along with their descriptions and practical actions (see Table 4 and Figure 6).

Table 4. Summarization table of best practices identified through literature review for project procurement

Best Practice	***Description***	***Practical Actions***
Early Selection of CMR (Construction Manager as Constructor)	Select the CMR early in the project timeline to maximize their impact on the project outcome.	Influence on design decisions, cost estimation accuracy, design quality improvement.

Verification and Education in CM/GC Process	Verify past project outcomes and educate stakeholders on GMP negotiations and CM-GC processes.	Contractor's historical performance, personnel qualifications.
Utilization of Best Value (BV) Procurement	Use when the project scope is well-defined to balance cost with performance quality.	Project scope clarity, cost-component evaluation.
Training for the Evaluation Committee	Train committee members to enhance their ability to assess proposals effectively.	Fairness and transparency of the procurement process.
Detailed Evaluation and Debriefings	Provide specific, actionable feedback in evaluations and debriefings to clarify decision rationales and improve future proposal quality.	Transparency in ratings and decision-making processes.
Assessment of QBS (Qualifications-Based Selection) Over Best-Value Selection	Focus on proposer qualifications to foster innovative solutions and flexible risk management.	Innovation encouragement, risk management.

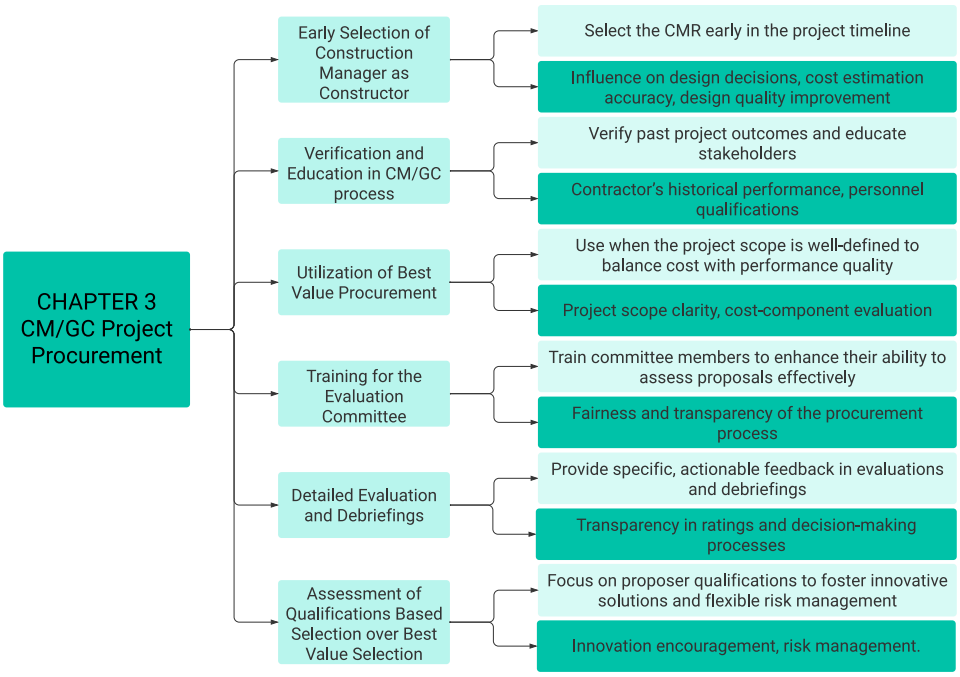

Figure 6. Tree diagram of best practices for project procurement

6.3 Best Practices regarding CM/GC Preconstruction Services

In the field of construction project management, the preconstruction phase is a crucial phase when foundational decisions are made, setting the stage for the success or challenges of the entire project. Depicting this phase requires strategic plans with the insights and expertise of an entire project team. Here are a series of best practices drawn from literature and industrial reports.

At the core of effective project management is bringing the construction manager on board early. This allows them to get deeply involved in the design process from the beginning, helping to make sure the project plan works smoothly and efficiently. By having the construction manager work closely with the team, including architects and engineers, right from the start, it ensures everyone

is on the same page with the project's goals and schedule. Here is an example from the CM/GC manual of Oregon Department of Transportation (see Figure 7). This diagram highlights the importance of early engagement of construction manager or contractor for CM/GC. It details key design milestones at 15%, 30%, 60%, 90%, and 100% completion, aligned with corresponding pricing milestones in CM/GC preconstruction services. An early work amendment facilitates the transition between phases, with a Guaranteed Maximum Price (GMP) amendment executed after the 90% design milestone, signaling the start of construction phase. This diagram underscores the importance of synchronizing design progression with preconstruction activities for efficient project delivery.

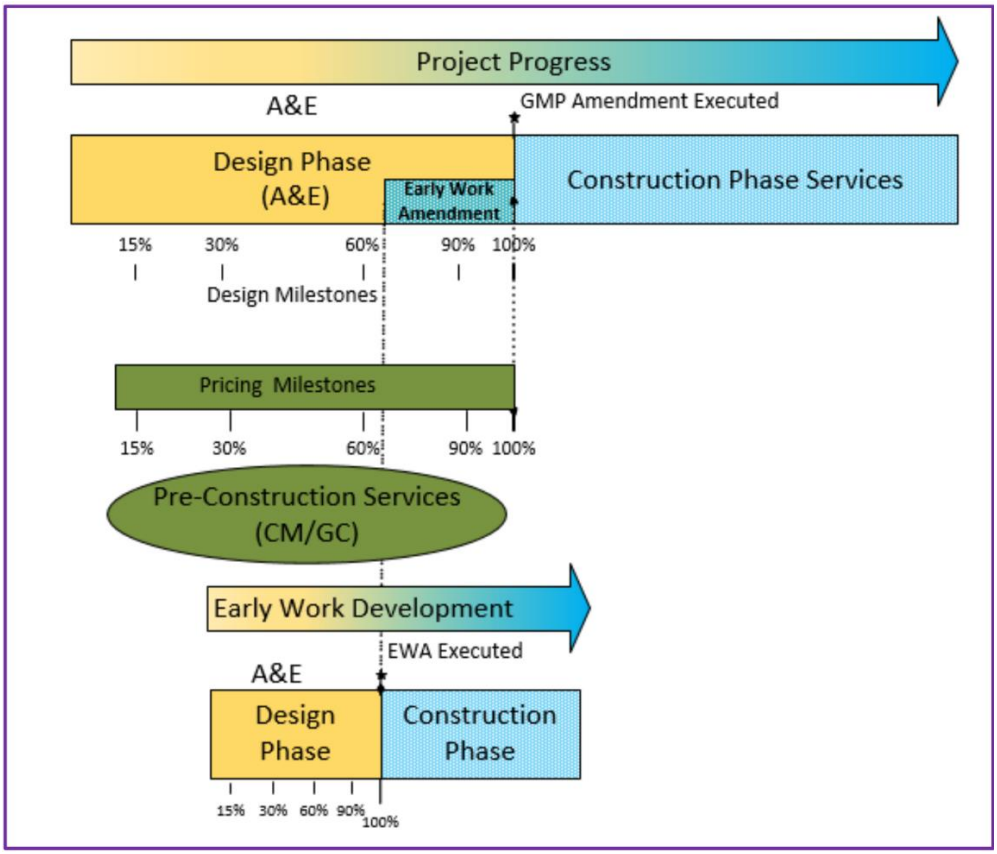

Figure 7. Progress from design phase to construction phase and the timing of early work (Oregon Department of Transportation, 2020)

Managing risks early in a project could also promote the construction process to become more smoothly. By identifying potential risks early, the project team can create strategies to avoid them. This not only helps the project meet safety and environmental standards but often exceeds them. Working closely with third parties and following regulations are crucial steps in making the project sustainable and well-integrated into the community.

As the project plans get more detailed, the focus transits to making the most out of every resource through value analysis and cost modeling. This involves carefully choosing materials and methods that provide the best balance of cost, quality, and efficiency. Breaking the project into smaller, manageable parts helps with detailed planning and resource allocation, making sure each part of the project gets the necessary focus and resources it needs.

Based on the nuances and specifics discussed above, several best practices are identified and recommended for ***preconstruction services*** of appropriate project delivery methods. Here are a table and a tree diagram demonstrating the Best Practices, along with their descriptions and practical actions (see Table 5and Figure 8).

Table 5. Summarization table of best practices identified through literature review for preconstruction services

Best Practice	***Description***	***Practical Actions***
Early engagement of construction managers	Align construction managers with project decisions early with long-term goals and feasibility.	Conducting kickoff meetings to align project goals and team roles.
Risk management and sustainability practices	Identification of all potential internal and external project risks.	Implement a structured risk assessment process using quantitative tools; develop and apply tailored mitigation strategies for each identified risk.
Scheduling for all project phases	Inclusion of all project phases, milestones, and dependencies with adequate buffers.	Use dynamic scheduling software to create and maintain an optimized project timeline; regularly update the schedule based on project changes and milestones achieved.
Value optimization and resource allocation	Optimization of project value without compromising on quality or sustainability.	Utilizing advanced software for cost modeling and scheduling, breaking down projects into work packages for better control.
Conduct constructability reviews	Evaluation of project designs for practicality and efficiency in construction.	Regularly schedule constructability review meetings involving engineers, architects, and the construction manager to ensure all design aspects are feasible and optimized for construction.

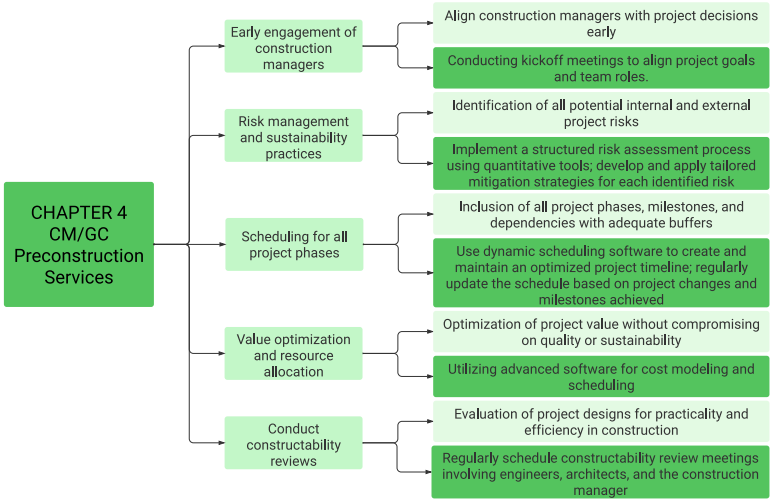

Figure 8. Tree diagram of best practices for preconstruction services

6.4 Best Practices regarding Project Cost and Negotiated Construction Price (NCP)

Effective management of project costs and strategic negotiation of construction prices are also crucial to ensuring that construction projects remain within budget and are completed on favorable financial terms. The adoption of Guaranteed Maximum Price (GMP) contracts plays a significant role in this process. By setting a cap on project costs, GMP contracts minimize financial risks by

preventing expenses from surpassing a predetermined limit, ensuring that project stakeholders have a clear financial framework within which to operate (Forbes & Ahmed, 2010). Additionally, employing Independent Cost Estimators (ICE) enhances this approach by providing unbiased assessments of proposed prices, ensuring that the Department of Transportations (DOTs) secures the best possible market value for their products (D. Gransberg et al., 2015). This is further promoted by the inclusion of clauses in contracts, which encourage contractors to adopt cost-saving measures by sharing the benefits of any underspend, thus aligning contactor motivations with project financial goals.

For projects that are structured in phases or consist of multiple work packages, the use of progressive GMPs can be particularly effective. This strategy allows for the adjustment of cost ceilings based on real-time project developments, providing better control and flexibility throughout the construction process. Incorporating Negotiated Construction Price (NCP) contracts alongside these strategies can further enforce fiscal discipline by placing a firm cap on expenses, compelling contractors to manage costs proactively without the possibility of passing overruns back to the client. Regular negotiated reviews of construction prices are essential, enabling project managers to continuously monitor financial performance against the budget and make necessary adjustments. Transparent communication and meticulous documentation of all cost-related discussions and changes ensure that every financial decision is clear, justified, and traceable. This not only aids in maintaining budget control but also fosters a cooperative and transparent environment among all project participants, ultimately contributing to the successful financial execution of construction projects.

Furthermore, here is a table comparing several contract types as well as their definition, ideal use, benefits, and risks (see Table 6). This table outlines various types of construction contracts for different project needs and risk profiles, directly impacting the negotiation strategies and cost management practices employed. For straightforward projects with a clear scope, Lump Sum contracts offer simplicity and potential for higher profit margins but require accurate cost estimation to avoid eating into those margins. Time & Material Cost contracts are suited for projects where the scope may evolve, providing flexibility but lacking incentives for cost savings. Cost-Plus contracts, used for projects likely to change significantly, offer flexibility and simpler bidding processes, though they require careful justification of overhead costs and entail higher upfront financial commitment from the owner. Unit Price contracts work well for repetitive tasks, ensuring predictable profit margins but can complicate total volume predictions and delay payments due to remeasurement. The Guaranteed Maximum Price (GMP) contracts cap the project costs, providing a financial ceiling and incentivizing cost-effective management, yet they may require more extensive negotiation. These strategies collectively enhance project outcomes by aligning contractual terms with project management objectives, fostering an environment where cost efficiency is optimized alongside quality and timeliness.

Table 6. Comparison between several contract types (D. D. Gransberg & Shane, 2015; Minchin et al., 2014; Shakya, 2013)

Contract Type	Definition	Ideal Use	Benefits	Risks
Lump Sum	Fixed total price is set for the entire project	Straightforward projects with clear scope of work	Simplifies bidding Potential for higher profit margins	Estimating mistakes may eat into margins Errors are employed on large projects

Time & Material Cost	Contractor is reimbursed for the cost of materials as well as labor at an established pay rate.	Projects with a well-defined scope of work	Flexible for unexpected cost increases Easy negotiations	Logging costs is time consuming No incentives for cost or time saving.
Cost-Plus Contract	Owner reimburses contractor for costs (material, labor, overhead) plus a set profit margin	Projects that involve changes throughout	More flexible Simpler estimation and bidding	Some costs (e.g., Overhead) can be hard to justify High upfront cash requirement
Unit Price Contract	Work is divided into separable units, which the contractor bills for individually	Repetitive jobs without an estimate of the amount of work required	Simplified invoicing Consistent profit margins	Difficult to predict total volume. Remeasurement can delay payment.
Guaranteed maximum price	Contractor establishers an upper limit for the costs, and absorbs the excess thereafter	Projects with relatively few unknown variables	Quicker bidding and financing Incentivizes saving	Contractors absorb cost overages. Can take longer to negotiate

Based on the nuances and specifics discussed above, several best practices are identified and recommended for ***project costs and negotiated construction price*** of appropriate project delivery methods. Here are a table and a tree diagram demonstrating the Best Practices, along with their descriptions and practical actions (see Table 7 and Figure 9).

Table 7. Summarization table of best practices identified through literature review for project costs and negotiated construction price

Best Practice	***Description***	***Practical Actions***
Utilize Guaranteed Maximum Price Contracts	Implement GMP contracts to cap the project cost, providing a clear ceiling for budgeting purposes. This helps in managing financial risk as it prevents costs from exceeding a set limit.	Ensure that the scope of work is well-defined and quantified in the design documents to accurately establish the GMP, which includes direct costs, indirect costs, profit margins, and contingencies.
Employ Independent Cost Estimators	Engage Independent Cost Estimators to provide unbiased cost estimates. This assists in validating the contractor's proposed prices and ensures the Department of Transportation (DOT) receives fair market value.	Select experienced and credible ICE professionals who can accurately assess cost implications and provide reliable advice on cost-related issues.
Incentive Clauses for Cost Savings	Include incentive clauses in contracts where any cost savings achieved below the GMP are shared between the DOT and the CM/GC firm. This encourages cost-effective practices and innovation from the contractor while ensuring project affordability.	Structure incentives to reward significant cost-saving measures without compromising on quality or compliance with project specifications.
Progressive GMP for Phased Projects	For projects divided into phases or work packages, use progressive GMPs where each phase or package has its own GMP. This allows for more precise cost control and adjustments based on project realities as they unfold.	Ensure each work package or phase is well-defined with clear deliverables and milestones before setting its GMP, allowing for accurate and realistic pricing.
Regular Price Reviews	Conduct regular reviews of the project costs against the GMP during the project life	Establish periodic review points that align with major project milestones or

	cycle. This helps in identifying any potential cost overruns early and allows for timely interventions.	at the completion of significant work packages.
Transparent Communication and Documentation	Maintain open and transparent communication with all contractual parties regarding cost issues. Proper documentation of all cost-related decisions and changes is vital for clarity and future reference.	Implement a systematic approach to documentation and ensure all cost adjustments or negotiations are well-recorded and justifiable.

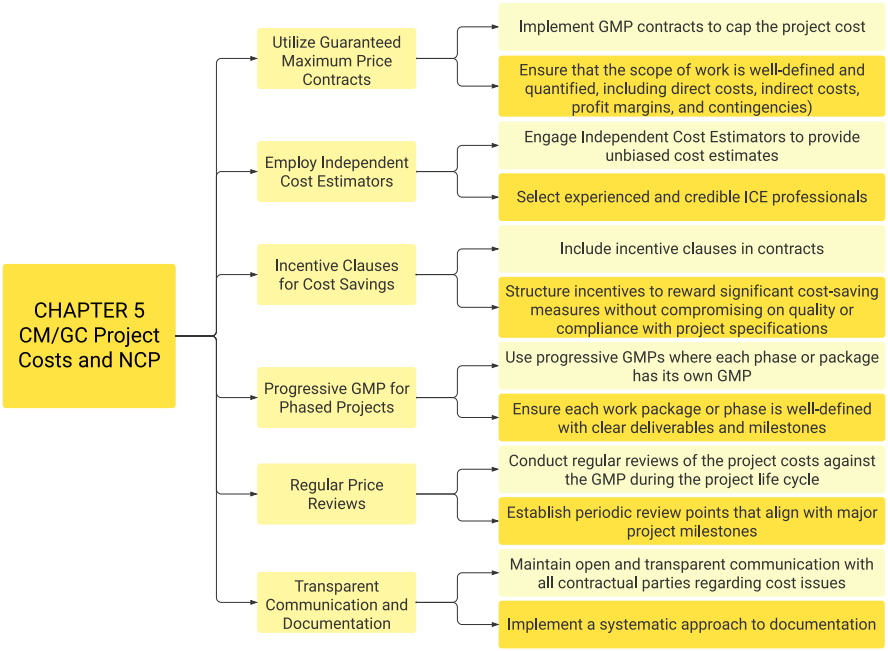

Figure 9. Tree diagram of best practices for project costs and negotiated construction price

7. MATCHING BEST PRACTICES WITH CASE STUDIES

Here are several cases from the Department of Transportation in Utah, California, Colorado, Oregon, Minnesota, Tennessee, and Michigan (see Table 8).

Table 8. Summary of case studies from different DOTs

Case Name	Location	Description	Duration	Source
I-15 Shepard Lane Interchange Improvement	Farmington, Utah	The Utah Department of Transportation (UDOT) is constructing a new interchange along I-15 at Shepard Lane in Farmington, Utah. This new interchange will help alleviate congestion, connect communities, and improve safety for all modes of transportation.	From March 2024 to June 2026	(UDOT, 2022, 2024)
State Route 37 Sears Point to Mare Island Improvement Project	Within or adjoins the counties of Sonoma, Solano, and Napa, CA	The Project is to improve traffic flow and peak travel times and increase vehicle occupancy (number of people moved per vehicle) in the SR 37 corridor. It proposes improvements at the existing roadway elevation to provide additional capacity during peak periods to improve traffic flow while minimizing environmental impacts.	From May 2019 to Feb 2025	(Caltrans, 2021, 2024a, 2024b)
I-70 Floyd Hill Project	I-70 from east of the Floyd Hill/Beaver Brook exit to Colorado Blvd.	The I-70 Floyd Hill Project, from west of Evergreen to eastern Idaho Springs, encompasses an eight-mile section of the I-70 Mountain Corridor that acts as an economic gateway for the state of Colorado and the nation.	From July 2023 to late 2028	(CDOT, 2024)
OR 43: Sellwood Bridge Interchange Area	OR-43 & S Macadam Ave, Portland, OR 97239	The OR 43: Sellwood Bridge IAMP has been developed in conjunction with the Sellwood Bridge project, which is currently in the late stages of the environmental review process. The Sellwood Bridge project includes replacement of the Sellwood Bridge and reconstruction of the interchange with OR 43 (SW Macadam Avenue).	N/A	(Garrett, 2010; Multnomah County, 2024)
Hwy 53 Relocation	Hwy 53 in Virginia, MN	The project scope involves abandonment of the existing TH 53 in the area of the United Taconite mine and relocation of a segment of TH 53, approximately two miles in length, between Cuyana Drive and Second Avenue in Virginia, MN.	From Nov 2015 to Nov 2017	(MnDOT, 2024)
Bridge Replacement on I-240 of Memphis, Shelby County	Poplar Avenue interchange to south of the existing Norfolk Southern (NS) Railroad Bridge	The bridge replacement on I-240 provided an eight-lane I-240 mainline facility. The project will improve vertical and horizontal clearance along I-240 at the bridge crossings, reduce the construction time and impacts to the motoring public, area businesses and residents.	From 2018 to June 2019	(Alfred Benesch & Company, 2015; TDOT, 2016)
M-39 ramps K & L over I-94 Bridge Rehabilitation	Allen Park, Wayne County, Michigan	This project involves the rehabilitation of the M-39 ramps K and L over I-94 in the City of Allen Park, Wayne County, Michigan. The project is necessary for the structure and safety of the ramps, which are very much crucial in maintaining flow uninterrupted and keeping the public safe.	N/A	(MDOT, 2023)

7.1 Case Study I: I-15 Shepard Lane Interchange Improvement (UDOT, 2024)

Utah Department of Transportation (UDOT) has been constructing a new interchange section along the Interstate 15 highway (I-15) at Shepard Lane in Farmington, Utah. Not only help alleviate the traffic congestion, but this new interchange could also connect surrounding communities and improve the safety for transportation. This interchange will enhance the walking and biking facilities over I-15 at Shepard Lane and along Park Lane (see Figure 10). Improvements of this project include: a new diamond interchange on I-15 at Shepard Lane; a new noise wall on the east side of I-15 between Shepard Lane and Park Lane; a direct connection from 1500 West to the Shepard Lane interchange; construction of a new roadway between Innovator Drive and 1500 West; Construction of new shared-use facilities at Shepard Lane and Park Lane; and removal of the existing Shepard Lane bridge at I-15. Regarding the CM/GC best practices involved in this project, here is a summary table illustrating the specific measures or actions of this case based on the contract terms and conditions document from UDOT.

Figure 10. I-15 Shepard Lane interchange improvement demonstration (UDOT, 2024)

Table 9. Evaluation of Case Study I in terms of Best Practice structure (UDOT, 2022)

Chapter	***Best Practice***	***Compared with GDOT***	***Specified (1), Not Specified (0), or Unique (+1)***
Chapter 2: CM/GC Project Identification and Selection	Assessment of Project Complexity and Risk	Emphasizes more on professional standards and compliance with legal and regulatory requirements, while GDOT emphasizes more on risk identification and mitigation.	Specified (1)
	Alignment with Project Requirements	Requires supervision by skilled and experienced professionals under strict professional standards. Services must comply with customary professional standards.	Specified (1)
	Utilization of Early Contractor Involvement	Not explicit but inferred by the emphasis on compliance and standards.	Not Specified (0)

	Stakeholder Collaboration and Goal Alignment	Focuses on maintaining professional standards, which indirectly promotes stakeholder collaboration.	Specified (1)
	Regulatory and Legislative Considerations	Insists on full compliance with all applicable laws, regulations, and professional standards.	Specified (1)
	Comprehensive Evaluation of Proposals	Sets high standards for proposal evaluations, instead of utilizing the best-value procurement mentioned in GDOT.	Specified (1)
	Conflict of Interest and Integrity Clauses	Includes specific provisions related to conflict of interest and integrity standards, ensuring transparency and ethical conduct. These are more detailed compared to the general ethical guidelines in GDOT.	Unique (+1)
	Non-Discrimination Provisions	Includes extensive non-discrimination clauses aligning with various federal and state laws, ensuring all project activities comply with these guidelines.	Unique (+1)
Chapter 3: CM/GC Project Procurements	Early Selection of CMR	Does not explicitly mention timing but implies importance of compliance from project start.	Not Specified (0)
	Verification and Education in CM/GC Process	Requires adherence to the highest professional standards and detailed compliance documentation	Specified (1)
	Utilization of Best Value (BV) Procurement	Might imply high standards, though not explicitly focused on best-value procurement	Not Specified (0)
	Training for the Evaluation Committee	Does not specify training but requires adherence to high professional standards, which may necessitate trained evaluators to assess compliance.	Not Specified (0)
	Detailed Evaluation and Debriefings	Stresses thorough record-keeping and compliance, supporting comprehensive evaluations and debriefings.	Specified (1)
	Assessment of QBS Over Best-Value Selection	Focuses more on compliance and standards, less on qualitative or value-based assessments.	Not Specified (0)
	Detailed Insurance Requirements	Specifies various insurance policies that consultants must hold, which are detailed extensively compared to GDOT's requirements.	Unique (+1)
	Certifications on Lobbying and Debarment	Requires certifications regarding lobbying and debarment, ensuring that consultants have not engaged in disallowed activities.	Unique (+1)
	Background Checks for Employment	Might require background checks for all employees of the consultant, ensuring security and reliability in personnel involved in sensitive projects.	Unique (+1)
Chapter 4: CM/GC Preconstruction Services	Early engagement of construction managers	Focuses on compliance implies a structured approach but lacks explicit details on early engagement.	Not Specified (0)
	Risk management and sustainability practices	Mandates compliance with all professional standards, likely includes risk management.	Specified (1)
	Scheduling for all project phases	Insists on compliance with professional standards, likely includes proper scheduling practices.	Specified (1)
	Value optimization and resource allocation	Focuses on standards and compliance suggests implicit resource allocation optimization, though not explicitly mentioned.	Not Specified (0)

	Conduct constructability reviews	Implies a structured approach to project planning that would include constructability review, although not explicitly stated.	Not Specified (0)
	Emphasis on Professional Standard of Care	Requires services under the contract to adhere strictly to professional standards, ensuring compliance with Utah's local laws and professional regulations which is not distinctly outlined in the GDOT manual.	Unique (+1)
	Record Keeping and Audit Provisions	Specifies that the consultant must keep detailed records available for audits for at least seven years, emphasizing transparency and accountability in financial and project management.	Unique (+1)
	Comprehensive Environmental and Accessibility Regulations	Demands strict adherence to environmental laws and accessibility requirements, ensuring projects cater to environmental conservation and accessibility.	Unique (+1)
Chapter 5: Project Cost and NCP	Utilize Guaranteed Maximum Price Contracts	Does not explicitly discuss GMP but maintains a focus on rigorous compliance and standards	Not Specified (0)
	Employ Independent Cost Estimators	Requires adherence to professional standards, which could include the use of independent cost assessments to ensure integrity.	Specified (1)
	Incentive Clauses for Cost Savings	Does not explicitly mention incentives but mandates high performance, possibly supported by incentives.	Not Specified (0)
	Progressive GMP for Phased Projects	Does not explicitly address progressive GMP, focusing more on adherence to strict standards.	Not Specified (0)
	Regular Price Reviews	Detailed monitoring and compliance checks implies in the contract terms, likely include regular price reviews.	Specified (1)
	Transparent Communication and Documentation	Mandates detailed record-keeping and compliance, supporting transparent communication and documentation.	Specified (1)
	Specific Compliance with Utah Codes and Federal Regulations	Focuses very specifically about compliance with Utah state codes and federal regulations, ensuring local legal compliance is integrated deeply into project execution.	Unique (+1)
	Indemnification and Liability	Has detailed indemnification and liability clauses that outline the responsibility of the consultant to indemnify the department against damages, which are more explicitly detailed than in GDOT.	Unique (+1)

7.2 Case Study II: State Route 37 Sears Point to Mare Island Improvement Project (Caltrans, 2024a, 2024b)

To improve traffic flow and peak travel times and increase vehicle occupancy in the SR 37 corridor between SR 121 and the Mare Island interchange, California Department of Transportation (Caltrans) has been conducting a project in the SR 37 corridor. This project proposes improvements at the existing roadway elevation to provide additional capacity for peak periods, which could improve the traffic flow while minimizing the environmental impacts. The preferred alternative proposes to reconfigure the existing lanes of SR-37 from a point west of the SR-121 intersection to the Walnut Avenue Overcrossing at Mare Island (see Figure 11).

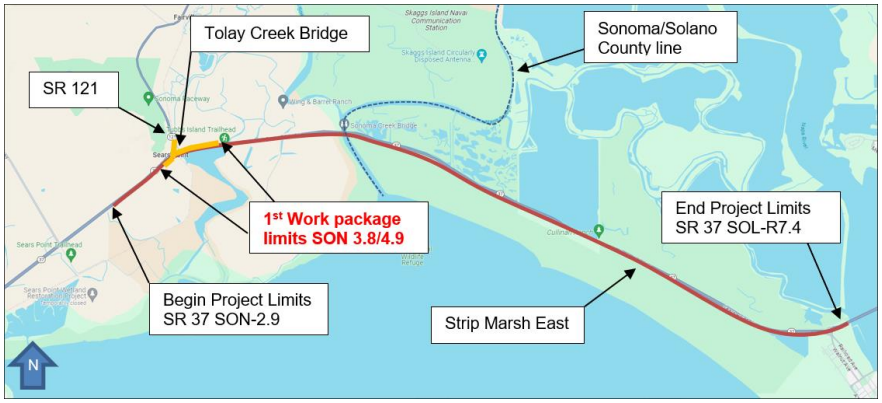

Figure 11. SR-37 Sears point to Mare island improvement project demonstration (Caltrans, 2024b)

The plan includes replacing the Tolay Creek Bridge and expanding the highway to four lanes, offering two continuous lanes in each direction. An eastbound High-Occupancy Vehicle (HOV) lane will be introduced on the left side near the SR-121/SR-37 intersection, starting approximately 0.6 miles west of SR-121. The eastbound left-turn lane will be extended about 0.5 miles westward. A westbound HOV lane on the left side will commence at the Mare Island Interchange. Regarding the CM/GC best practices involved in this project, here is a summary table illustrating the specific measures or actions of this case based on the contract terms and conditions document from Caltrans (Caltrans, 2021).

Table 10. Evaluation of Case Study II in terms of Best Practice structure (Caltrans, 2021)

Chapter	***Best Practice***	***Compared with GDOT***	***Specified (1), Not Specified (0), or Unique (+1)***
Chapter 2: CM/GC Project Identification and Selection	Assessment of Project Complexity and Risk	Engages in comprehensive risk management and registers as part of the project planning phase.	***Specified (1)***
	Alignment with Project Requirements	Specifies alignment through detailed project selection criteria that assess fit for CM/GC delivery.	***Specified (1)***
	Utilization of Early Contractor Involvement	Explicitly involves the contractor involvement in the design process to influence project outcomes positively, especially noted during the preconstruction services.	***Specified (1)***
	Stakeholder Collaboration and Goal Alignment	Implements structured workshops and partnering sessions to foster collaboration and align goals.	***Specified (1)***
	Regulatory and Legislative Considerations	Integrates specific state legislation and federal rules into its processes.	***Specified (1)***
	Comprehensive Evaluation of Proposals	Uses qualifications-based selection (QBS) focusing on the experience and expertise of contractors.	***Specified (1)***
	Comprehensive Integration of Federal and State Legislation	Integrates federal and state legislative requirements directly into the project identification and selection process, ensuring that projects selected for the CM/GC method comply with all relevant regulations from the outset.	***Unique (+1)***

Chapter 3: CM/GC Project Procurements	Early Selection of CMR	Selects CMR early but places greater emphasis on the integration of the CMR during the design phase.	***Specified (1)***
	Verification and Education in CM/GC Process	Includes specific training sessions and educational workshops to enhance understanding of the CM/GC process.	***Specified (1)***
	Utilization of Best Value (BV) Procurement	Focuses on QBS instead of BV, ensuring best value through a comprehensive evaluation of capabilities.	***Not Specified (0)***
	Training for the Evaluation Committee	Does not explicitly mention, likely includes training as part of its comprehensive stakeholder engagement.	***Not Specified (0)***
	Detailed Evaluation and Debriefings	Detailed evaluation followed by structured debriefings to ensure clarity and transparency in decision-making.	***Specified (1)***
	In-depth Pre-NEPA Approval Procurement and Requirements	Details on handling procurements before environmental clearances (NEPA) are integrated, ensuring compliance with environmental laws before project commitments are made.	***Unique (+1)***
Chapter 4: CM/GC Preconstruction Services	Early engagement of construction managers	Highly structured early engagement to leverage CM expertise throughout the project lifecycle.	***Specified (1)***
	Risk management and sustainability practices	Integrates risk workshops and sustainability reviews into the project management processes.	***Specified (1)***
	Scheduling for all project phases	Detailed scheduling is integrated with early contractor involvement and risk management strategies.	***Specified (1)***
	Value optimization and resource allocation	Explicitly incorporates value engineering and resource allocation strategies into early project phases.	***Specified (1)***
	Conduct constructability reviews	Conducts detailed constructability reviews as part of the design review workshops.	***Specified (1)***
	Detailed Approach to Risk Workshops and Innovation Management	Includes formal risk workshops and innovation management during preconstruction to identify, assess, and mitigate potential risks and foster innovative construction and design techniques.	***Unique (+1)***
	Extensive Use of Work Packages	Utilizes work packages in the preconstruction phase, allowing phased construction planning, aligning with overall project scheduling and funding strategies.	***Unique (+1)***
Chapter 5: Project Cost and NCP	Utilize Guaranteed Maximum Price Contracts	Employs GMP, with detailed provisions for adjustments based on project phases.	***Specified (1)***
	Employ Independent Cost Estimators	Does not explicitly mention the using of independent cost estimators but integrates them more thoroughly into the ongoing project evaluation process.	***Not Specified (0)***
	Incentive Clauses for Cost Savings	Includes explicit incentive clauses to promote cost-saving measures by contractors.	***Specified (1)***
	Progressive GMP for Phased Projects	Explicitly outlines progressive GMP use for phased projects, allowing flexibility and adjustments as projects evolve.	***Specified (1)***
	Regular Price Reviews	Regular price reviews are likely integrated into the project lifecycle to maintain budget adherence and manage financial risks, though not explicitly specified.	***Not Specified (0)***

	Transparent Communication and Documentation	Highly values transparent communication, with detailed documentation standards and regular updates throughout project phases.	***Specified (1)***
	Pilot Delegation to Districts	Involves specific districts in the oversight of the CM/GC contractor procurement process, which can include aspects of project cost management and contract negotiations.	***Unique (+1)***
	Explicit Value Engineering and Cost Benefit Analysis	Engages in value engineering and cost-benefit analysis to optimize project costs and benefits during the NCP development stages.	***Unique (+1)***

7.3 Case Study III: I-70 Floyd Hill Project (CDOT, 2024)

This project involves an eight-mile segment of the I-70 Mountain Corridor, stretching from just west of Evergreen to eastern Idaho Springs. Serving as an economic gateway for Colorado and the nation, this corridor hosts long-time residents, numerous large and small businesses, and substantial tourism traffic. Recognizing the pressing need for upgrades due to aging infrastructure, the Colorado Department of Transportation (CDOT) dedicated several years to studying the corridor (see). They engaged with residents, stakeholders, and community leaders to draft potential solutions. With the support of these stakeholders and national leaders, construction of the I-70 Floyd Hill Project is now underway, beginning with its initial phases.

Figure 12. Rendering of the completed I-70 Floyd Hill project's central section looking south (CDOT, 2024)

This project includes several steps, which are: (1) add a third westbound I-70 travel lane; (2) rebuild bridges; (3) construct a missing two-mile section of the frontage road between US 6 and the Hidden Valley/Central City Parkway interchanges; (4) build an extended on-ramp from US 6 onto eastbound I-70 for slow-moving vehicles to have more room to merge; (5) improve traffic flow and access at interchanges and intersections; (6) straighten roadway curves; (7) improve the Clear Creek Greenway trail; (8) implement environmental mitigation; (9) install two permanent air quality monitors. According to the map of the I-70 Floyd Hill project, it highlights the three geographic phases that project will be built in (see Figure 13).

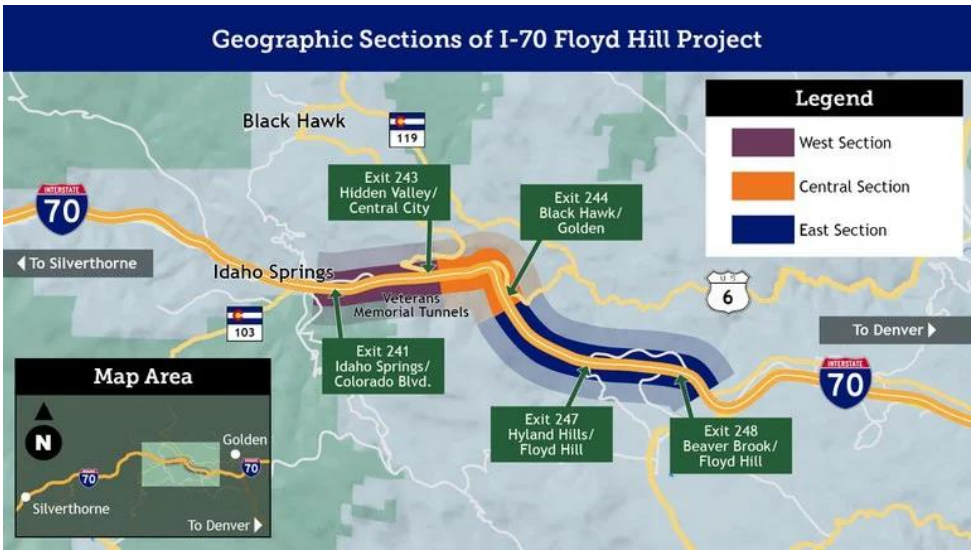

Figure 13. Geographic sections of I-70 Floyd Hill project (CDOT, 2024)

Several benefits are concluded, since this project not only addresses the bottleneck on I-70 at Floyd Hill and rebuild bridges to improve reliability of travel time, but also improves traffic flow, design speeds, and access at intersections and interchanges. Regarding the CM/GC best practices involved in this project, here is a summary table illustrating the specific measures or actions of this case based on the contract terms and conditions document from CDOT (see Table 11).

Table 11. Evaluation of Case Study III in terms of Best Practice structure (CDOT, 2015)

Chapter	***Best Practice***	***Compared with GDOT***	***Specified (1), Not Specified (0), or Unique (+1)***
Chapter 2: CM/GC Project Identification and Selection	Assessment of Project Complexity and Risk	Addressed in multiple sections where project risks, their assessment, and mitigation strategies are discussed.	***Specified (1)***
	Alignment with Project Requirements	Discussed in terms of aligning project goals with project requirements during the goal-setting workshop.	***Specified (1)***
	Utilization of Early Contractor Involvement	Mentioned as part of the design development and constructability reviews, which involve early contractor input.	***Specified (1)***
	Stakeholder Collaboration and Goal Alignment	Covered in the sections describing goal-setting workshops that include multiple stakeholders.	***Specified (1)***
	Regulatory and Legislative Considerations	Addressed through compliance with federal regulations and CDOT's procedures during the design and preconstruction phases.	***Specified (1)***
	Comprehensive Evaluation of Proposals	Explains in the contractor selection process where proposals are evaluated based on a range of criteria including cost, qualifications, and experience.	***Specified (1)***
	Project Delivery Selection Matrix (PDSM)	Employs a structured Project Delivery Selection Matrix to systematically evaluate and select the most suitable project delivery method.	***Unique (+1)***

Chapter 3: CM/GC Project Procurements	Early Selection of CMR	Mentioned as part of the early selection processes to enhance collaboration and design input	***Specified (1)***
	Verification and Education in CM/GC Process	Discussed in context of ongoing project oversight and educational workshops for project teams, but not explicitly mentioned.	***Not Specified (0)***
	Utilization of Best Value (BV) Procurement	Best value criteria are used during the contractor selection process, emphasizing qualifications and overall project benefit.	***Specified (1)***
	Training for the Evaluation Committee	While not explicitly mentioned, the comprehensive evaluation processes imply training for those involved in project evaluations.	***Not Specified (0)***
	Detailed Evaluation and Debriefings	Occurs during the proposal evaluation phase, while not explicitly mentioned.	***Not Specified (0)***
	Concurrent Procurement Recommendations	Recommends concurrent procurement of the design consultant, CM/GC contractor, and independent cost estimator to maximize efficiency and collaboration.	***Unique (+1)***
Chapter 4: CM/GC Preconstructi on Services	Early engagement of construction managers	Highlighted through the involvement in the preconstruction services, contributing to design and planning.	***Specified (1)***
	Risk management and sustainability practices	Extensively covered through risk workshops, management plans, and sustainability reviews during the project lifecycle.	***Specified (1)***
	Scheduling for all project phases	Addressed by the requirement for detailed project scheduling, coordinated with all project stakeholders.	***Specified (1)***
	Value optimization and resource allocation	Discussed in terms of optimizing project outcomes through strategic resource management during the contract negotiation phases.	***Specified (1)***
	Conduct constructability reviews	Specifically mentioned as part of the iterative design process involving the contractor.	***Specified (1)***
	Collaborative Design Development	Involves all stakeholders in the design process to ensure that all aspects of the project are covered effectively	***Unique (+1)***
Chapter 5: Project Cost and NCP	Utilize Guaranteed Maximum Price Contracts	Described as part of the financial management strategies to control project costs, not specifically mentioning GMP	***Not Specified (0)***
	Employ Independent Cost Estimators	Covered under the procedures for cost estimation and review by independent cost estimators to ensure budget adherence.	***Specified (1)***
	Incentive Clauses for Cost Savings	Not detailed extensively described in the manual.	***Not Specified (0)***
	Progressive GMP for Phased Projects	Implements progressive GMP adjustments, allowing for flexibility in managing costs as project scopes evolve.	***Specified (1)***
	Regular Price Reviews	Part of the ongoing financial management and cost control practices mentioned throughout the project phases, though not explicitly mentioned.	***Not Specified (0)***
	Transparent Communication and Documentation	Emphasized across multiple sections, ensuring all project communications and documentations are clear and accessible to all stakeholders.	***Specified (1)***

7.4 Case Study IV: OR 43 Sellwood Bridge Interchange Area (Garrett, 2010; Multnomah County, 2024)

The OR 43 Sellwood Bridge Interchange Area Management Plan (IAMP) was developed in conjunction with the project to replace the Sellwood Bridge and reconstruct the interchange with OR 43 (SW Macadam Avenue). This project is in the late stages of environmental review in 2010. The bridge serves as a crucial connector between Oregon 43 on the west side and SE Tacoma Street on the east side, crossing the Willamette River (see Figure 14). This infrastructure is significant for local and regional travel markets, linking various parts of Portland and surrounding counties. The IAMP was created to manage the circulation and access within the interchange area to support existing and future development, adhering to the City of Portland's Comprehensive Plan. This plan outlines specific management strategies for local businesses, residences, and parklands, ensuring they are served adequately while minimizing traffic impacts and preserving the environmental and recreational qualities of the area.

Figure 14. Geographic sections of OR 43 Sellwood Bridge Project (Garrett, 2010)

Several benefits are addressed for this project, including ensuring safety and efficiency for the functionality of the interchange as well as balancing mobility and local access to business and residences. Regarding the CM/GC best practices involved in this project, here is a summary table illustrating the specific measures or actions of this case based on the contract terms and conditions document from ODOT.

Table 12. Evaluation of Case Study IV in terms of Best Practice structure (Garrett, 2010; Multnomah County, 2024)

Chapter	***Best Practice***	***Compared with GDOT***	***Specified (1), Not Specified (0), or Unique (+1)***
Chapter 2: CM/GC Project	Assessment of Project Complexity and Risk	Provides comprehensive risk management plans, including regular risk workshops and a detailed risk management plan during pre-construction.	***Specified (1)***

Identification and Selection	Alignment with Project Requirements	Utilizes a variety of assessment tools and detailed project planning to ensure project meet transportation and community needs.	***Specified (1)***
	Utilization of Early Contractor Involvement	Explicitly involves contractors early in the design process.	***Specified (1)***
	Stakeholder Collaboration and Goal Alignment	Implements structured collaboration strategies including workshops, continuous stakeholder engagement, and alignment sessions.	***Specified (1)***
	Regulatory and Legislative Considerations	Integrates specific legislative and regulatory frameworks into every project phase.	***Specified (1)***
	Comprehensive Evaluation of Proposals	Emphasizes qualifications-based selection (QBS), focusing on contractor expertise to ensure high-quality project delivery.	***Specified (1)***
	Structured Decision Making with Stakeholder Integration	Employs a structured decision-making process that heavily integrates stakeholder input.	***Unique (+1)***
Chapter 3: CM/GC Project Procurements	Early Selection of CMR	Emphasizes the importance of early contractor engagement, not specifically for selection of CMR.	***Not Specified (0)***
	Verification and Education in CM/GC Process	Specifies the need for ongoing verification of project standards and compliance, alongside structured educational workshops for all parties involved to ensure a comprehensive understanding of the CM/GC processes.	***Specified (1)***
	Utilization of Best Value (BV) Procurement	Mentioned generally but specifics are not covered.	***Not Specified (0)***
	Training for the Evaluation Committee	Not explicitly mentioned in the manual but could be inferred by the stress of workshops.	***Not Specified (0)***
	Detailed Evaluation and Debriefings	Referenced indirectly through discussions on project evaluation.	***Not Specified (0)***
	Early Contractor Engagement with Best Value Consideration	Emphasizes early engagement of the contractor during the procurement phase itself, facilitating a more collaborative relationship throughout the project.	***Unique (+1)***
Chapter 4: CM/GC Preconstruction Services	Early engagement of construction managers	Explicitly addressed in the introduction part where early contractor involvement is emphasized.	***Specified (1)***
	Risk management and sustainability practices	Includes comprehensive strategies for risk management plans and risk workshops.	***Specified (1)***
	Scheduling for all project phases	Addressed in various chapters, including planning and construction phases.	***Specified (1)***
	Value optimization and resource allocation	Emphasizes the optimization of project value through strategic resource allocation, though not explicitly detailed.	***Not Specified (0)***
	Conduct constructability reviews	Conducted regularly to assess the project plans and identify potential issues before they arise during construction, mentioned as part of the pre-construction services.	***Specified (1)***

Chapter 5: Project Cost and NCP	Utilize Guaranteed Maximum Price Contracts	Mentioned generally in the introduction, not extensively explaining the details.	***Not Specified (0)***
	Employ Independent Cost Estimators	Addressed under roles in the manual, not detailed enough about specific cost estimators	***Not Specified (0)***
	Incentive Clauses for Cost Savings	Although aligning the contractor's interests with those of ODOT, it's not mentioned in the manual at all.	***Not Specified (0)***
	Progressive GMP for Phased Projects	Allows for the use of progressive GMP amendments for phased projects, as the project scope evolves through different phases, accommodating changes and unexpected conditions without compromising the financial framework or project goals.	***Specified (1)***
	Regular Price Reviews	Implements a system of transparent cost management and regular price reviews throughout the project's duration.	***Specified (1)***
	Transparent Communication and Documentation	General guidelines are mentioned, but specifics are not detailed.	***Not Specified (0)***

7.5 Case Study V: Hwy 53 Relocation (MnDOT, 2024)

The Minnesota Department of Transportation TH 53 Relocation Project was one of the major infrastructure projects in Northern Minnesota. The Mesabi Iron Range, an area with huge deposits of iron ore, required that the highway be moved so that continuous iron ore could be extracted beneath the existing highway alignment. Thus, the relocation of a segment of US Highway 53 was done which spanned about 3.2 miles of the highway between Eveleth and Virginia, Minnesota. Due to its easement agreement with a mining company, the Minnesota Dept. of Transportation had to relocate 3.2 miles of U.S. Highway 53 in the Mesabi Iron Range in northern Minnesota to allow mining operations to continue. According to the 1960 agreement the MnDOT is required to relocate this higway segment which includees the construction of Minnesota's tallest bridge, at 1,132 feet. United Taconite, a susidiary of Cliffs Natural Resources will mine iron ore underneath the old route.

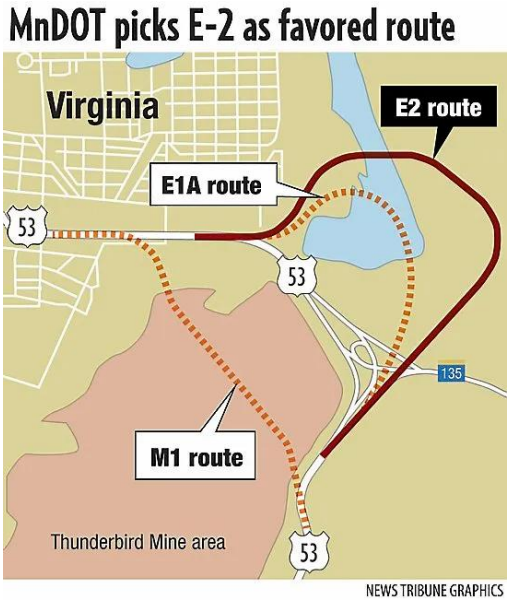

Figure 15. Highway 53 Alternative routes

Table 13. Evaluation of Case Study V in terms of Best Practice structure (MnDOT, 2024)

Chapter	***Best Practice***	***Compared with GDOT***	***Specified (1), Not Specified (0), or Unique (+1)***
Chapter 2: CM/GC Project Identification and Selection	Assessment of Project Complexity and Risk	Participate in risk assessment and mitigation workshops, including pricing and assignment of risk during pre-construction.	***Specified (1)***
	Alignment with Project Requirements	Not explicitly mentioned, but the RFP is in relation to the alignment of the project goals.	***Not Specified (0)***
	Utilization of Early Contractor Involvement	The CM/GC contractor works closely with MnDOT and the design consultant from the preconstruction phase	***Specified (1)***
	Stakeholder Collaboration and Goal Alignment	MnDOT, the design team, and the CM/GC Contractor form a partnership to improve overall quality and develop a project that adheres to the budget.	***Specified (1)***
	Regulatory and Legislative Considerations	The project considers compliance with Federal, State and Local laws including National Environmental Policy Act.	***Specified (1)***
	Comprehensive Evaluation of Proposals	MnDOT conducts best-value selections where technical qualifications are evaluated in addition to price. Technical interviews are also conducted.	***Specified (1)***
	Co-Location	During design, key individuals of the Project Team will be co-located at a facility in the Twin Cities metro area. The CM/GC Contractor, at a minimum, will be required to have their Project Manager co-located with the Project Team.	***Unique (+1)***
	Equal employment opportunity	MnDOT will assure that equal employment opportunity will be offered to all persons without regard to race, color, creed, religion, national origin, sex, marital status, status with regard to public assistance, membership or activity in a local commission, disability, sexual orientation, or age.	***Unique (+1)***

Chapter 3: CM/GC Project Procurements	Early Selection of CMR	Does not mention early selection of CMR but early selection of contractor in CM/GC is mentioned.	***Not Specified (0)***
	Verification and Education in CM/GC Process	The CM/GC is required to submit a Project experience table which outlines the history of their projects, the role, project cost, key personnel, and schedule performance.	***Specified (1)***
	Utilization of Best Value (BV) Procurement	The MnDOT's, CM/GC Contractor selection process consists of a one-step best-value selection (BV) process.	***Specified (1)***
	Training for the Evaluation Committee	There is no mention of Training for the Evaluation Committee.	***Not Specified (0)***
	Detailed Evaluation and Debriefings	MnDOT follows a structured evaluation process and also provides debriefings to any unsuccessful proposer upon written request.	***Specified (1)***
	Right to Use Ideas and Information from Proposals	All ideas included in the successful or unsuccessful Proposer's Proposal will become the property of MnDOT.	***Unique (+1)***
	Organizational Chart	The proposal should have a graphical organizational chart that shows the flow of the "chain of command" with lines identifying, by name and working title, participants who are responsible for major functions to be performed.	***Unique (+1)***
Chapter 4: CM/GC Preconstruction Services	Early engagement of construction managers	The CM/GC contractor who acts as a construction manager works closely with MnDOT and the design consultant from the preconstruction phase.	***Specified (1)***
	Risk management and sustainability practices	The CM/GC will help MnDOT identify, price, and mitigate risks. The project goal is to avoid and minimize impacts to the environment but there is no specific mention of any practices.	***Not Specified (0)***
	Scheduling for all project phases	The CM/GC provides schedule that shall clearly identify milestones, showing the proposed start and finish dates.	***Specified (1)***
	Value optimization and resource allocation	Does not mention anything about value optimization and resource allocation.	***Not Specified (0)***
	Conduct constructability reviews	The CM/GC will continuously provide informal oversight and constructability reviews with the MnDOT team on various elements of the project and provide recommendations.	***Specified (1)***
	Disadvantaged Business Enterprises	Disadvantaged Business Enterprises (DBEs), and other small businesses shall have the maximum feasible opportunity to participate in contracts financed in whole or in part with public funds.	***Unique (+1)***
	Milestone Reviews	The CM/GC will participate in formal milestone reviews meetings, which are anticipated to occur during at the 30%, 60%, and 90% design submissions.	***Unique (+1)***
Chapter 5: Project Cost and NCP	Utilize Guaranteed Maximum Price Contracts	MnDOT may elect to utilize a Guaranteed Maximum Price bid, but specifics are not mentioned.	***Not Specified (0)***
	Employ Independent Cost Estimators	MnDOT will retain an independent cost estimator (ICE) through a separate procurement process, with whom the CM/GC Contractor will coordinate throughout the design phase of the Project.	***Specified (1)***

	Incentive Clauses for Cost Savings	The construction services fee, which includes the contractor's profit, may incorporate any incentives but no clauses are specified.	***Not Specified (0)***
	Progressive GMP for Phased Projects	No mention of GMP for different phases of the project.	***Not Specified (0)***
	Regular Price Reviews	MnDOT expects the CM/GC Contractor to help MnDOT design and construct the project within budget, but there is no specific procedure for price reviews	***Not Specified (0)***
	Transparent Communication and Documentation	Transparent communication is implied through the expectations of ongoing collaboration and documentation, but specifics are not detailed.	***Not Specified (0)***
	Construction Services Fee	The CM/GC Contractor shall propose a construction services fee, or a fixed markup for the Work expressed as a percentage of the total construction cost on the form provided.	***Unique (+1)***

7.6 Case Study VI: Bridge Replacement on I-240 of Memphis, Shelby County (Alfred Benesch & Company, 2015; TDOT, 2016)

The bridge replacement on I-240 provided an eight-lane I-240 mainline facility through the Poplar Avenue interchange to south of the existing Norfolk Southern (NS) Railroad Bridge. The project will improve vertical and horizontal clearance along I-240 at the bridge crossings, reduce the construction time and impacts to the motoring public, area businesses and residents. The project aims to minimize impacts to NS Railroads and replace the 56-year-old structure.

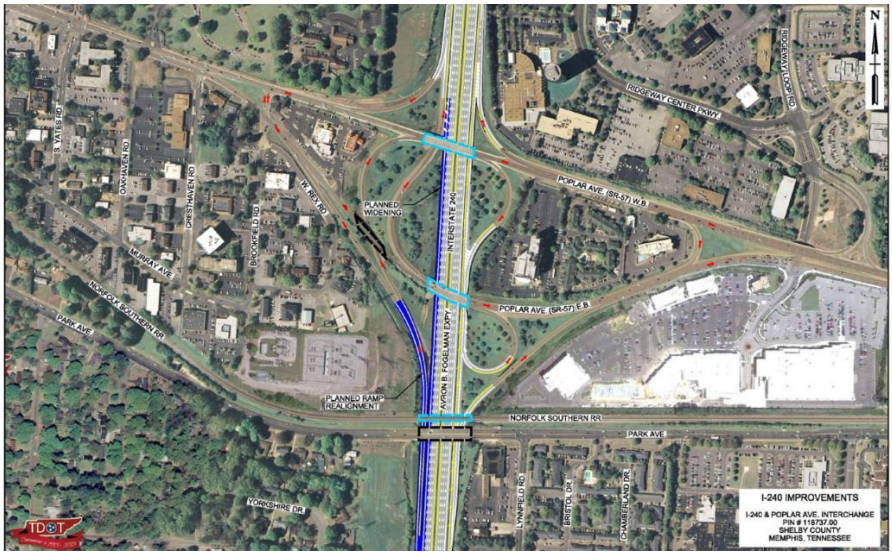

Figure 16. Proposed Improvements of I-240 (Alfred Benesch & Company, 2015)

The existing bridges across I-240 include the westbound and eastbound SR 57 (Poplar Avenue) bridges, the Norfolk Southern Railroad bridge, and the Park Avenue bridge were structurally deficient and without seismic retrofit. Thus, this project replaced them to make it safe and up to the current codes. Regarding the CM/GC best practices involved in this project, here is a summary

table illustrating the specific measures or actions of this case based on the contract terms and conditions document from TDOT.

Table 14. Evaluation of Case Study VI in terms of Best Practice structure (Alfred Benesch & Company, 2015; TDOT, 2016)

Chapter	***Best Practice***	***Compared with GDOT***	***Specified (1), Not Specified (0), or Unique (+1)***
Chapter 2: CM/GC Project Identification and Selection	Assessment of Project Complexity and Risk	Participate in risk assessment and mitigation workshops. Also, identify the potential risks (including financial risks) and methods to mitigate them.	***Specified (1)***
	Alignment with Project Requirements	The CM/GC is required to discuss their approach in providing successful services and how it applies to meeting TDOT's project goals.	***Specified (1)***
	Utilization of Early Contractor Involvement	The contractor shall partner with the Design Consultant and the TDOT Management Team as part of the design team and provide input on schedule, phasing, constructability, material availability, and cost.	***Specified (1)***
	Stakeholder Collaboration and Goal Alignment	The Integrated Project Team (TDOT, Design Consultant, and the Contractor) collaborates to deliver the project in less time and at a lower total cost, while meeting the project goals.	***Specified (1)***
	Regulatory and Legislative Considerations	The RFP states that the CM/GC shall conform to all applicable State and Federal regulations and recognized industry, safety, environmental, and design standards, but there is no specific mention about Regulatory and Legislative Considerations.	***Not Specified (0)***
	Comprehensive Evaluation of Proposals	Proposals are reviewed and scored by a TDOT Selection Panel. A bunch of evaluation criteria along with interviews are conducted to comprehensively evaluate proposals.	***Specified (1)***
	Accelerated Bridge Construction	The CM/GC will advance the knowledge, experience and cost efficiency of TDOT and the local construction industry in Accelerated Bridge Construction (ABC) and CM/GC project delivery.	***Unique (+1)***
Chapter 3: CM/GC Project Procurements	Early Selection of CMR	Does not mention early selection of CMR but early selection of contractor is mentioned.	***Not Specified (0)***
	Verification and Education in CM/GC Process	There is no mention about Verification and Education in the CM/GC Process.	***Not Specified (0)***
	Utilization of Best Value (BV) Procurement	TDOT intends to evaluate, select, and award one CM/GC contract to the top ranked Proposer based on a Best Value Selection	***Specified (1)***
	Training for the Evaluation Committee	There is no mention of Training for the Evaluation Committee.	***Not Specified (0)***
	Detailed Evaluation and Debriefings	TDOT has evaluation criteria which cover proposals, interviews, and CM/GC fee proposals in various sections.	***Specified (1)***
Chapter 4: CM/GC Preconstruction Services	Early engagement of construction managers	The CM/GC will be involved in the design development by providing input to TDOT and the Design Consultant concerning various design elements and constructability throughout the CM/GC process	***Specified (1)***

	Risk management and sustainability practices	The CM/GC will identify project risks and develop an initial risk management plan.	***Specified (1)***
	Scheduling for all project phases	The CM/GC will provide a discussion of the schedule aspects of ABC (Accelerated Bridge Construction). They will also collaboratively integrate and optimize the construction schedule with the design schedule.	***Specified (1)***
	Value optimization and resource allocation	Value optimization and resource allocation are not explicitly mentioned but can be inferred in the process of CM/GC.	***Not Specified (0)***
	Conduct constructability reviews	An important role of the Contractor is to evaluate the constructability of the design plans to reduce risk in all phases with innovative approaches to meet budget goals.	***Specified (1)***
	Detailed Approach to Risk Workshops.	CM/GC will attend the workshops which aims to align with the goals and tasks of the project.	***Unique (+1)***
Chapter 5: Project Cost and NCP	Utilize Guaranteed Maximum Price Contracts	CM/GC will prepare and submit a Guaranteed Maximum Price (GMP) proposal and if it is accepted, a TDOT Construction Contract will be compiled and executed.	***Specified (1)***
	Employ Independent Cost Estimators	TDOT will secure an independent cost estimator.	***Specified (1)***
	Incentive Clauses for Cost Savings	When developing contingency risk-sharing pool, TDOT anticipates that any cost savings in construction that may occur after the GMP has been established will be shared with the Contractor in such proportion as the parties may determine during the pre-construction phase of the Project.	***Specified (1)***
	Progressive GMP for Phased Projects	No mention of GMP for different phases of the project.	***Not Specified (0)***
	Regular Price Reviews	There is no specific procedure for regular price reviews	***Not Specified (0)***
	Transparent Communication and Documentation	The CM/GC will take part in workshops to Establish Communication and Document Control Plans.	***Specified (1)***
	Opinion of Probable Construction Cost estimates (OPCC	Provide up to three progressively refined Opinion of Probable Construction Cost estimates (OPCC) at designated design milestones.	***Unique (+1)***

7.7 Case Study VII: M-39 ramps K & L over I-94 Bridge Rehabilitation (MDOT, 2023)

This project involves the rehabilitation of the M-39 ramps K and L over I-94 in the City of Allen Park, Wayne County, Michigan. The project is necessary for the structure and safety of the ramps, which are very much crucial in maintaining flow uninterrupted and keeping the public safe. Rehabilitation will address technical and constructability challenges associated with post-tensioned concrete box girder structures and bearing replacements, hence reducing maintenance needs in the near future to a minimum. The project will increase worker and traveling public safety, enhanced mobility through minimizing impacts to I-94 and M-39 traffic, and better coordination with affected utility companies. Through the early engagement of a Construction Manager/General Contractor in design, MDOT anticipates leveraging private-sector expertise in achieving cost-effective, expedited delivery of the project. Regarding the CM/GC best practices involved in this

project, here is a summary table illustrating the specific measures or actions of this case based on the contract terms and conditions document from MDOT.

Figure 17. M-39 ramps K & L over I-94 Bridge Rehabilitation (MDOT, 2023)

Table 15. Evaluation of Case Study VII in terms of Best Practice structure (MDOT, 2023)

Chapter	***Best Practice***	***Compared with GDOT***	***Specified (1), Not Specified (0), or Unique (+1)***
Chapter 2: CM/GC Project Identification and Selection	Assessment of Project Complexity and Risk	Risk management is a continuous process throughout the lifecycle of a CM/GC project, and regular review and update of identified risks is required, as well as identifying and assessing new risks.	***Specified (1)***
	Alignment with Project Requirements	The Project Supervisor is responsible for ensuring that the Project is constructed in accordance with the Project requirements.	***Specified (1)***
	Utilization of Early Contractor Involvement	The CM/GC is being selected early in the project to join the Project Team.	***Specified (1)***
	Stakeholder Collaboration and Goal Alignment	The CM/GC will promote collaboration with the MDOT Project Team during Preconstruction and construction services. They should demonstrate an understanding of how the Project goals will be met through the CM/GC process.	***Specified (1)***
	Regulatory and Legislative Considerations	The CONTRACTOR will work in accordance with applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities.	***Specified (1)***
	Comprehensive Evaluation of Proposals	MDOT will evaluate all responsive SOQs and measure each Submitter's response against the Project goals and evaluation criteria set forth in the RFQ, resulting in a numerical score for each SOQ.	***Specified (1)***
	Changes to Organizational Structure	All changes in key personnel or a major participant from the selected CM/GC's SOQ during the pre-construction or construction phase of the Project shall be approved by MDOT in writing.	***Unique (+1)***
Chapter 3: CM/GC	Early Selection of CMR	The CM/GC is being selected early in the project to join the Project Team.	***Specified (1)***

Project Procurements	Verification and Education in CM/GC Process	Key Personnel will be evaluated based on the extent they meet and/or exceed minimum qualifications including, but not limited to, relevant education, training, certification, and experience.	***Specified (1)***
	Utilization of Best Value (BV) Procurement	MDOT does not mention any procurement methods for Best Value.	***Not Specified (0)***
	Training for the Evaluation Committee	There is no mention of Training for the Evaluation Committee.	***Not Specified (0)***
	Detailed Evaluation and Debriefings	MDOT has detailed evaluation criteria and they may also provide feedback via face-to-face meeting, phone or email at the discretion of the IC PM.	***Specified (1)***
	QA/QC Plan	The CM/GC will provide a Quality Assurance/Quality Control (QA/QC) document which has the details of review of plans and specifications, perform quantity take-offs, perform constructability reviews, help identify and mitigate risks, make recommendations, etc.	***Unique (+1)***
Chapter 4: CM/GC Preconstruction Services	Early engagement of construction managers	The CM/GC will be involved early from the design phase.	***Specified (1)***
	Risk management and sustainability practices	Risk management is a continuous process throughout the lifecycle of a CM/GC project, and regular review and update of identified risks is required, as well as identifying and assessing new risks.	***Specified (1)***
	Scheduling for all project phases	MDOT requires CM/GC to provide schedule for each project phases.	***Specified (1)***
	Value optimization and resource allocation	CM/GC will provide recommendations for optimizing all aspects of project management and coordination.	***Specified (1)***
	Conduct constructability reviews	Identify potential construction and constructability issues and risks for each to assist the Project Team in selecting the appropriate design for the Project.	***Specified (1)***
	Provide alternative design concepts	The CM/GC will provide alternative design concepts and offer suggestions with respect to the means and methods, materials, innovations, maintaining traffic concepts, and construction sequencing to improve efficiency, cost effectiveness, completeness or clarity.	***Unique (+1)***
Chapter 5: Project Cost and NCP	Utilize Guaranteed Maximum Price Contracts	The contractor will prepare and submit to MDOT a Construction Services Cost Proposal that includes a Guaranteed Maximum Price (GMP).	***Specified (1)***
	Employ Independent Cost Estimators	MDOT will procure a separate Independent Cost Estimator (ICE), with whom MDOT and the CM/GC will collaborate throughout the design phase of the Project.	***Specified (1)***
	Incentive Clauses for Cost Savings	There is no mention of any incentives for cost savings.	***Not Specified (0)***
	Progressive GMP for Phased Projects	No mention of GMP for different phases of the project.	***Not Specified (0)***
	Regular Price Reviews	There is no specific procedure for regular price reviews.	***Not Specified (0)***
	Transparent Communication and Documentation	The Submitter shall demonstrate how communication will occur with internal staff, subcontractors, MDOT, MDOT's consultants, as well as their anticipated communication and involvement with the public.	***Specified (1)***

	Basis of Cost	The CM/GC will provide an approach to structuring the cost estimate and state all relevant assumptions.	***Unique (+1)***

8. COMPARATIVE ANALYSIS OF CM/GC BEST PRACTICES BETWEEN GDOT AND OTHER DOTS

Below is the summarization table for best practices identified in the seven case studies.

Table 16. Summary of Case Studies in terms of Best Practices

Chapter	*Best Practice*	*Specified in which other DOTs*		*Metric for Comparative Analysis*
Chapter 2: CM/GC Project Identification and Selection	Assessment of Project Complexity and Risk	***UDOT, Caltrans, CDOT, ODOT, MnDOT, TDOT, MDOT***	*7*	***R&P***
	Alignment with Project Requirements	***UDOT, Caltrans, CDOT, ODOT, TDOT, MDOT***	*6*	***S&P***
	Utilization of Early Contractor Involvement	***Caltrans, CDOT, ODOT, MnDOT, TDOT, MDOT***	*6*	***S&P***
	Stakeholder Collaboration and Goal Alignment	***UDOT, Caltrans, CDOT, ODOT, MnDOT, TDOT, MDOT***	*7*	***EE***
	Regulatory and Legislative Considerations	***UDOT, Caltrans, CDOT, ODOT, MnDOT, MDOT***	*6*	***S&P***
	Comprehensive Evaluation of Proposals	***UDOT, Caltrans, CDOT, ODOT, MnDOT, TDOT, MDOT***	*7*	***S&P***
	Conflict of Interest and Integrity Clauses	***Unique to UDOT.***	*1*	***S&P***
	Non-Discrimination Provisions	***Unique to UDOT.***	*1*	***S&P***
	Comprehensive Integration of Federal and State Legislation	***Unique to CALTRAN.***	*1*	***S&P***
	Project Delivery Selection Matrix (PDSM)	***Unique to CDOT.***	*1*	***S&P***
	Structured Decision Making with Stakeholder Integration	***Unique to ODOT.***	*1*	***S&P***
	Co-Location	***Unique to MnDOT.***	*1*	***DCR***
	Equal employment opportunity	***Unique to MnDOT.***	*1*	***S&P***
	Accelerated Bridge Construction	***Unique to TDOT.***	*1*	***EE***
	Changes to Organizational Structure	***Unique to MDOT.***	*1*	***EE***
Chapter 3: CM/GC Project Procurements	Early Selection of CMR	***CALTRAN, CDOT & MDOT.***	*3*	***S&P***
	Verification and Education in CM/GC Process	***UDOT, Caltrans, ODOT, MnDOT, MDOT***	*5*	***S&P***
	Utilization of Best Value (BV) Procurement	***CDOT, MnDOT & TDOT.***	*3*	***S&P***
	Training for the Evaluation Committee	***Not Specified in any of the DOTs.***	*0*	***S&P***
	Detailed Evaluation and Debriefings	***UDOT, Caltrans, MnDOT, TDOT, MDOT.***	*5*	***S&P***
	Assessment of QBS Over Best-Value Selection	***Not Specified in any of the DOTs.***	*0*	***S&P***
	Detailed Insurance Requirements	***Unique to UDOT.***	*1*	***S&P***
	Certifications on Lobbying and Debarment	***Unique to UDOT.***	*1*	***S&P***

	Background Checks for Employment	***Unique to UDOT.***	***1***	***S&P***
	In-depth Pre-NEPA Approval Procurement and Requirements	***Unique to CALTRAN.***	***1***	***S&P***
	Concurrent Procurement Recommendations	***Unique to CDOT.***	***1***	***S&P***
	Early Contractor Engagement with Best Value Consideration	***Unique to ODOT.***	***1***	***S&P***
	Right to Use Ideas and Information from Proposals	***Unique to MnDOT.***	***1***	***S&P***
	Organizational Chart	***Unique to MnDOT.***	***1***	***S&P***
	QA/QC Plan	***Unique to MDOT.***	***1***	***S&P***
Chapter 4: CM/GC Preconstruction Services	Early engagement of construction managers	***Caltrans, CDOT, ODOT, MnDOT, TDOT, MDOT***	***6***	***DCR***
	Risk management and sustainability practices	***UDOT, Caltrans, CDOT, ODOT, TDOT, MDOT***	***6***	***R&P***
	Scheduling for all project phases	***UDOT, Caltrans, CDOT, ODOT, MnDOT, TDOT, MDOT***	***7***	***EE***
	Value optimization and resource allocation	***CALTRAN, CDOT & MDOT.***	***3***	***EE***
	Conduct constructability reviews	***Caltrans, CDOT, ODOT, MnDOT, TDOT, MDOT***	***6***	***DCR***
	Emphasis on Professional Standard of Care	***Unique to UDOT.***	***1***	***DCR***
	Record Keeping and Audit Provisions	***Unique to UDOT.***	***1***	***EE***
	Comprehensive Environmental and Accessibility Regulations	***Unique to UDOT.***	***1***	***EE***
	Detailed Approach to Risk Workshops and Innovation Management	***Unique to CALTRAN.***	***1***	***R&P***
	Extensive Use of Work Packages	***Unique to CALTRAN.***	***1***	***DCR***
	Collaborative Design Development	***Unique to CDOT.***	***1***	***DCR***
	Disadvantaged Business Enterprises	***Unique to MnDOT, MDOT & TDOT.***	***1***	***S&P***
	Milestone Reviews	***Unique to MnDOT.***	***1***	***EE***
	Provide alternative design concepts	***Unique to MDOT.***	***1***	***DCR***
Chapter 5: Project Cost and NCP	Utilize Guaranteed Maximum Price Contracts	***CALTRAN, TDOT & MDOT.***	***3***	***R&P***
	Employ Independent Cost Estimators	***UDOT, CDOT, MnDOT, TDOT, MDOT.***	***5***	***R&P***
	Incentive Clauses for Cost Savings	***CALTRAN & TDOT.***	***2***	***R&P***
	Progressive GMP for Phased Projects	***CALTRAN, CDOT & ODOT.***	***3***	***R&P***
	Regular Price Reviews	***UDOT & ODOT.***	***2***	***R&P***
	Transparent Communication and Documentation	***UDOT, Caltrans, CDOT, TDOT, MDOT***	***5***	***EE***
	Specific Compliance with Utah Codes and Federal Regulations	***Unique to UDOT.***	***1***	***S&P***
	Indemnification and Liability	***Unique to UDOT.***	***1***	***S&P***

	Pilot Delegation to Districts	***Unique to CALTRAN.***	***1***	***S&P***
	Explicit Value Engineering and Cost Benefit Analysis	***Unique to CALTRAN.***	***1***	***DCR***
	Construction Services Fee	***Unique to MnDOT.***	***1***	***R&P***
	Opinion of Probable Construction Cost estimates (OPCC)	***Unique to TDOT.***	***1***	***R&P***
	Basis of Cost	***Unique to MDOT.***	***1***	***R&P***

CM/GC project delivery has gained traction among other DOTs as a method which integrates design and construction expertise early in the project lifecycle. In analyzing how the GDOT aligns with or diverges from established CM/GC best practices, four key metrics provide a meaningful framework for comparison, which are ***Selection and Procurement (S&P), Risk Allocation and Pricing Mechanisms (R&P), Depth Of Constructability Reviews (DCR),*** and ***Execution Efficiencies (EE)***. ***Selection and Procurement*** focuses on whether other DOTs emphasize best value or qualifications-based selection, the extent of early contractor involvement, and how proposals are evaluated. It mainly covers both chapter 2 and chapter 3 from the best practice structure mentioned in the previous sections. ***Risk Allocation and Pricing Mechanisms*** examines how agencies distribute risks and structure pricing within the project to incentivize cost control and schedule adherence. It mainly covers both chapter 4 and chapter 5 from the best practice structure mentioned in the previous sections. ***Depth of Constructability Reviews*** investigates the extent to which agencies prioritize constructability, collaborative design development, and the use of innovative tools such as digital modeling software or cloud-based platforms. It mainly covers chapter 4 from the best practice structure mentioned in the previous sections. ***Execution Efficiency*** explores how DOTs monitor project costs, schedules, and performance metrics to ensure on-time and on-budget delivery. In other words, it evaluates the adherence of cost and schedule during the construction lifecycle. It mainly covers chapter 4 from the best practice structure mentioned in the previous sections.

These metrics are chosen because they collectively address the core challenges and opportunities within the CM/GC process, including selecting the right project delivery approach, allocating risks fairly, leveraging the contractor's expertise during the design phase, and ensuring that time and cost goals are realistic and attainable. Each metric intersects GDOT's strategic objectives of delivering transportation projects more efficiently, maintaining budget integrity, and incorporating innovative methods to meet the state's growing infrastructure needs.

The following comparative analysis references common practices from seven DOTs: ***Utah (UDOT), California (Caltrans), Colorado (CDOT), Oregon (ODOT), Minnesota (MnDOT), Tennessee (TDOT), and Michigan (MDOT)***. The summarization table at the end of this section synthesizes these best practices, indicating where GDOT is aligned and where potential refinements could strengthen GDOT's CM/GC adoption.

8.1 Selection and Procurement

Procurement strategy in a CM/GC environment heavily affects the level of innovation and collaboration. Under a traditional low-bid approach, contractors may focus predominantly on meeting minimal specifications at the lowest cost. Conversely, best-value procurement encourages

creative solutions, placing weight on factors like technical approach, relevant experience, and track record of collaboration. Qualifications-based selection (QBS) can similarly emphasize experience and technical capability but may not always incorporate price or cost reasonableness as a factor in the initial decision.

Among the seven referenced DOTs, there is strong consensus on incorporating Early Contractor Involvement (ECI) into the procurement process. For instance, Utah (UDOT) explicitly requires early interaction between designers and contractors to optimize constructability. Caltrans and CDOT also specify the advantages of engaging the constructor at the earliest feasible stage to help shape design decisions. GDOT largely follows this trend by involving contractors early during preconstruction, particularly for complex projects. Regarding the procurement method, CDOT, MnDOT, and TDOT explicitly mention best-value procurement, highlighting a balance between technical merit and cost. GDOT's current practices for CM/GC projects do consider both price and qualifications but could benefit from further refinement. For instance, refining evaluation criteria to give additional weight to innovation, past performance on similar projects, and approach to risk could align GDOT more fully with the best-value model seen in other states. In terms of unique practices and gaps, several DOTs adopt specialized approaches or unique contract types, such as conflict of interest and integrity provisions (UDOT), or the "Project Delivery Selection Matrix" (CDOT), to ensure transparent and well-defined procurement. While GDOT addresses transparency in broad terms, adopting more formalized matrices or structured decision-making tools might refine the alignment between project goals and the procurement method.

Consequently, GDOT integrates early contractor involvement and recognizes the importance of qualifications in contractor selection, reflecting a partial alignment with best-value principles. As for refinement aspects, it's suggested that GDOT should introduce a more explicit best-value weighting for innovation and risk management in the proposal evaluation, which could strengthen project outcomes, especially on highly complex or high-impact projects.

8.2 Risk Allocation and Pricing Mechanisms

Risk allocation is especially essential to successful CM/GC delivery since it determines how project uncertainties such as unforeseen site conditions, design changes, or schedule accelerations are managed financially and contractually. Effective risk allocation could improve collaboration and reduce adversarial relationships, while poorly managed risk allocation might lead to inflated bids, excessive change orders, or legal disputes.

Most DOTs (UDOT, Caltrans, CDOT, ODOT, TDOT, MDOT) mention the importance of systematic risk assessment in early project phases. Risk assessment could be classified to standard approach and dynamic approach. A standard risk assessment is a planned, structured process to identify and evaluate potential risks in a given situation, typically conducted before an activity begins, while a dynamic risk assessment is a continuous process where risks are assessed in real-time as conditions change, allowing for immediate adjustments and responses to emerging hazards, often performed during an activity itself. Essentially, the key difference lies in their timing and adaptability to evolving situations. In terms of CM/GC context, dynamic risk assessment strategies include Progressive Guaranteed Maximum Price (Caltrans, CDOT, ODOT) and employing independent cost estimators (UDOT, CDOT, MnDOT, TDOT, MDOT), which enable ongoing risk adjustments as project design evolves. Regarding the use of Guaranteed Maximum Price

(GMP), Caltrans, TDOT, and MDOT specify the use of GMP contracts. This approach establishes an upper limit on cost, transferring much of the cost risk to the contractor while incentivizing shared cost savings. Although GDOT has experimented with GMP on selected projects, it tends to rely on more traditional mechanisms, such as negotiated lump sums or cost-plus agreements with target price. As for incentive mechanisms, some DOTs incorporate bonuses or incentives for cost savings or early completion. For example, Caltrans and TDOT are particularly explicit about this. GDOT's projects often include performance incentives, but these could be expanded or more systematically applied to encourage cost-saving innovations.

In conclusion, GDOT's CM/GC framework includes risk identification during preconstruction and attempts to allocate major technical and construction risks to the contractor. Open-book costing and negotiation, although not always standardized, are not uncommon. Introducing more formal risk-based pricing such as progressive GMP or dynamic contingency funds is highly recommended, which could help GDOT manage budget uncertainties more effectively and align incentives between GDOT and contractors.

8.3 Depth of Constructability Reviews

Constructability reviews leverage the contractor's expertise to identify design improvements, sequencing efficiencies, and potential field constraints. The effectiveness of these reviews significantly influences overall project performance, as early identification of design conflicts reduces rework and schedule slippage.

Six of the seven other DOTs emphasize the need for systematic constructability reviews (Caltrans, CDOT, ODOT, MnDOT, TDOT, MDOT). Many have formal guidelines or standardized checklists. Others, like CDOT, go further by integrating collaborative design development, ensuring that the contractor's input is continually revisited throughout the design phase. Regarding technology utilization, several agencies employ digital tools such as Building Information Modeling (BIM) and Digital Twins to enhance the quality and efficiency of constructability reviews. While not always explicitly mandated in their guidelines, the trend is clearly toward deeper digital integration. Currently, GDOT includes contractor feedback loops during preconstruction, but the degree to which these reviews are structured or supported by digital platforms can vary significantly from project to project. More standardized approaches could yield greater consistency and predictability in outcomes.

Therefore, GDOT embraces preconstruction services that encourage contractor input on constructability. This is a fundamental pillar of its CM/GC framework and is well-aligned with common best practices. As for future improvement, a more formalized or technology-enhanced process for constructability reviews is expected, which is similar to the robust models in place at Caltrans or CDOT. The adoption of these robust models could further reduce design conflicts and strengthen cost and schedule certainty.

8.4 Execution Efficiency

Ultimately, project success in CM/GC is measured by delivering projects on time, within budget, and at a high level of quality. Execution efficiency revolves around how rigorously agencies track and control costs, manage schedules, and adapt to evolving conditions.

All seven DOTs highlight the need for comprehensive scheduling across all project phases, with UDOT, Caltrans, CDOT, ODOT, MnDOT, TDOT, and MDOT specifying scheduling requirements in detail. Phased project delivery, especially when coupled with progressive GMP structures, offers more agility in responding to emerging schedule constraints. Five of the seven DOTs (UDOT, CDOT, MnDOT, TDOT, MDOT) explicitly emphasize the role of independent cost estimators or detailed cost reviews to ensure financial transparency. GDOT often uses independent cost estimates but may do so on a project-by-project basis. Additionally, DOTs with advanced CM/GC programs, such as Caltrans and TDOT, sometimes include incentive clauses for cost savings. Others, like Minnesota and Michigan, track project performance through meticulously updated KPIs (Key Performance Indicators). GDOT typically monitors cost and schedule performance, but the establishment of formal data-driven benchmarks or dashboards could provide more immediate and actionable insights.

In a nutshell, GDOT tracks cost and schedule adherence through regular project status updates and invests in preconstruction planning to reduce major overruns. Broader adoption of standardized performance metrics, more frequent cost comparisons with independent estimates, and advanced scheduling tools or analytics could further improve project outcomes under CM/GC.

In conclusion, across these four key metrics, GDOT aligns with several core elements of established CM/GC best practices, particularly regarding early contractor engagement, collaborative risk identification, and consistent preconstruction reviews. However, opportunities remain to refine the procurement approach, adopt more sophisticated risk-sharing methods, and deepen the integration of digital tools and performance metrics. It's suggested to enhance the procurement approach with explicit Best-Value Criteria. Formalize the weighting of innovation, past performance, and risk management during contractor selection. Adopting robust best-value methods will encourage higher technical quality and foster collaborative problem-solving. What's more, GDOT should adopt progressive or dynamic risk-sharing models. Explore Progressive GMP structures, dynamic contingency funds, and performance incentives to better manage budget uncertainties and align contractor motivations with GDOT's objectives. Last but not least, institutionalizing advanced constructability reviews and digital tools is recommended. Develop standardized digital protocols, such as 3D/4D BIM or digital twins, to streamline constructability reviews and improve real-time collaboration. This shift could reduce design revisions, shorten schedules, and minimize cost overruns. By addressing these focus areas, GDOT can further elevate its CM/GC program, optimizing project delivery performance and aligning more closely with the proven success factors identified across other DOTs.

9. LESSONS FROM CASE STUDIES AND RECOMMENDED INNOVATIONS IN CM/GC EXECUTION

The case studies examined in this report provide valuable insights into the effectiveness of CM/GC execution strategies across different transportation infrastructure projects. By analyzing the strengths and challenges of each project, key lessons emerge that can inform improvements in GDOT's CM/GC project delivery. This section summarizes overarching lessons learned and recommends innovative execution strategies to enhance efficiency, risk management, and stakeholder engagement in CM/GC projects.

9.1 Key Lessons from CM/GC Execution

Lesson for Execution #1: Early Contractor Involvement as a Core Strategy

A recurring success factor across multiple case studies, including the I-70 Floyd Hill Project by CDOT, SR-37 Sears Point to Mare Island Improvement by Caltrans, and M-39 Ramps K & L Over I-94 Bridge Rehabilitation project by MDOT, was the early involvement of the Construction Manager/General Contractor (CM/GC) during the design phase. This practice ensures that contractors provide valuable input on constructability, phasing, material selection, and scheduling, reducing design conflicts and cost overruns early in the project lifecycle. In contrast, projects that relied on regulatory compliance rather than structured contractor engagement experienced execution inefficiencies.

Consequently, GDOT should institutionalize structured preconstruction workshops where CM/GC contractors, designers, and project stakeholders collaboratively refine project scope, design elements, and risk assessments. This strategy enhances execution efficiency, reduces redesign efforts, and improves the integration of practical construction methodologies early in the project lifecycle.

Lesson for Execution #2: Structured Risk Management Through Continuous Assessment and Workshops

Risk assessment and mitigation played a crucial role in the Hwy 53 Relocation project by MnDOT, and M-39 Bridge Rehabilitation project by MDOT, where dynamic risk reviews allowed project teams to respond to evolving challenges in real-time. While GDOT already incorporates risk assessment in the early planning phase, a more dynamic risk management approach should be embedded throughout the execution phase.

CM/GC teams are suggested to conduct structured risk workshops at every major project milestones, where emerging challenges are reassessed, and mitigation strategies are refined based on evolving project conditions. Continuous risk evaluations ensure greater adaptability to unforeseen conditions, such as geotechnical variations, material shortages, or stakeholder conflicts, thereby reducing the likelihood of project delays and budget overruns.

Lesson for Execution #3: Adoption of Work Package-Based Execution for Large and Complex Projects

The SR-37 Sears Point to Mare Island Improvement project by Caltrans and I-240 Bridge Replacement project by TDOT utilized work packages to break down large projects into smaller, manageable segments. This allowed for parallel execution of different phases, optimizing scheduling efficiency. Traditional phased execution models, such as those used by GDOT, tend to be less flexible, leading to potential bottlenecks if unexpected issues arise. Therefore, instead of relying on traditional phased construction, where adjustments are challenging once a phase has commenced, GDOT should implement work package-based execution strategies for large infrastructure projects. By dividing projects into distinct, manageable phases, construction teams could better allocate resources, respond to unforeseen risks, and maintain steady progress without disrupting the entire project timeline. This model is particularly beneficial for projects in urban or high-traffic areas, where phased execution minimizes disruptions and ensures continuous functionality of surrounding infrastructure.

Lesson for Execution #4: Expanding the Use of Progressive Guaranteed Maximum Price (GMP) Contracts

Projects like the M-39 Ramps K & L Over I-94 Bridge Rehabilitation project by MDOT, and I-70 Floyd Hill project by CDOT successfully implemented progressive GMP contracts, allowing for budget flexibility while maintaining cost transparency. Unlike traditional fixed GMP contracts, where costs are locked early in the project, progressive GMPs enable phased cost adjustments based on refined design details, material price fluctuations, and evolving risk factors. GDOT should adopt progressive GMP frameworks for complex infrastructure projects, particularly those involving unpredictable conditions such as bridge rehabilitation, geotechnical challenges, or phased construction requiring dynamic adjustments. This approach provides financial adaptability, enhances contractor accountability, and ensures optimal budget utilization throughout project execution.

Lesson for Execution #5: Enhancing Procurement Efficiency Through Best-Value Selection

Multiple case studies, including the I-240 Bridge Replacement project by TDOT and SR-37 Sears Point Improvement project by Caltrans, emphasized best-value procurement over lowest-bid selection. Best-value procurement focuses on contractor qualifications, technical expertise, and past performance, ensuring that project execution aligns with quality expectations and innovation. GDOT could formalize a best-value evaluation matrix within its CM/GC framework, incorporating criteria such as contractor experience in similar projects, execution efficiency, sustainability measures, and risk mitigation capabilities. This will enable GDOT to select highly qualified contractors who bring value beyond cost competitiveness, ultimately leading to more efficient project execution.

Lesson for Execution #6: Institutionalizing Accelerated Bridge Construction (ABC) for Replacement and Rehabilitation Projects

The I-240 Bridge Replacement project by TDOT and M-39 Bridge Rehabilitation project by MDOT demonstrated the effectiveness of Accelerated Bridge Construction (ABC) techniques, such as prefabricated bridge elements, modular construction, and innovative material use, in reducing construction time and minimizing disruptions. Given Georgia's growing infrastructure

demands, GDOT could expand its implementation of ABC methodologies for bridge replacement and rehabilitation projects, especially in high-traffic corridors where extended closures pose significant public inconvenience. This can be achieved by integrating prefabrication into project designs, optimizing rapid deployment techniques, and streamlining approval processes for accelerated methods.

Lesson for Execution #7: Strengthening Stakeholder Coordination and Utility Management

Stakeholder engagement was a defining factor in the Sellwood Bridge Interchange (ODOT) and M-39 Ramps K & L (MDOT) projects, where early collaboration with utility providers, municipalities, and transportation agencies prevented costly delays and scope conflicts. Proactive engagement with local communities, utility companies, and business owners help align project objectives and minimized resistance. GDOT could enhance project execution by implementing formalized stakeholder coordination frameworks, requiring structured engagement with all affected parties before and during construction. This includes mandatory preconstruction utility coordination meetings, right-of-way resolution plans, and continuous engagement with local agencies to ensure alignment on project timelines and impacts. By institutionalizing stakeholder coordination as a core execution element, GDOT could reduce conflicts, accelerate approvals, and enhance overall project delivery efficiency.

Lesson for Execution #8: Implementing Transparent Communication and Documentation Control Plans

Transparent documentation played a pivotal role in ensuring project accountability in the M-39 and I-70 Floyd Hill projects, where CM/GC teams were required to provide detailed reporting on constructability assessments, risk adjustments, and budget tracking. GDOT could integrate digital project tracking tools and communication dashboards, where contractors, engineers, and project managers can collaborate in real time, ensuring all stakeholders have access to up-to-date execution data. By fostering a culture of transparency and accountability through structured documentation control, GDOT can improve decision-making, enhance cost visibility, and mitigate execution bottlenecks.

9.2 Recommended Innovations for GDOT in CM/GC Execution

According to the summarized best practices and lessons for execution for GDOT's CM/GC adoption, here is a table proposing recommended innovations for facilitating the execution process (see).

Table 17. Recommended Innovations for GDOT regarding CM/GC Execution

Recommended Innovation	***Best Practices***	***Specific Approaches***
Automated Constructability Review	• Early contractor involvement • Structured design reviews • Constructability workshops • Risk assessment meetings	Use AI-driven design integration tools to automatically detect potential constructability conflicts early in the planning phase.
Smart Scheduling & Predictive Analytics	• Flexible scheduling • Phased budget allocation	Implement AI-powered scheduling tools that analyze project risks in real-time, allowing for dynamic adjustments in execution phases.

Dynamic Contingency Models	• Progressive GMP contracts • Adaptive pricing strategies during execution	Introduce risk-based pricing that dynamically adjusts contingency budgets based on AI-driven project risk analytics.
Risk Analytics & Digital Twin Simulation	• Real-time risk updates through structured workshops • Continuous geotechnical risk assessments	Adopt digital twin technology to create real-time virtual models of construction projects, allowing for predictive risk assessments and proactive issue resolution before they impact execution.
Stakeholder Engagement Platforms	• Structured community engagement meetings to build trust and prevent execution delays.	Deploy digital platforms that provide real-time project updates, facilitate two-way communication, and ensure transparency through automated reporting and feedback loops.
Optimized Prefabrication & Logistics	• Use of Accelerated Bridge Construction (ABC) to reduce construction times and minimize traffic disruptions.	Use AI-powered planning tools to optimize prefabrication sequencing, streamline material logistics, and improve on-site installation efficiency, reducing execution delays.

10. DELPHI SURVEY FOR CONSOLIDATING GDOT-SPECIFIC BEST PRACTICES

In order to develop a robust, GDOT-specific set of best practices for CM/GC project delivery, a structured Delphi survey was conducted. The Delphi methods is suitable for building consensus among a panel of experts while preserving anonymity and allowing multiple iterations of feedback. This section is an overview of (1) the rationale for adopting this methodology, (2) survey procedure, (3) survey content and structure, (4) data analysis of survey response, and (5) actionable results for GDOT.

10.1 Rationale for Adopting the Delphi Methodology

The Delphi methodology is renowned for systematically eliciting and refining expert opinions, especially when the topic requires specialized knowledge and there is no single correct answer to that question. By gathering perspectives from individuals with hand-on experience or management responsibilities for CM/GC projects, the survey results are grounded in real-world applicability.

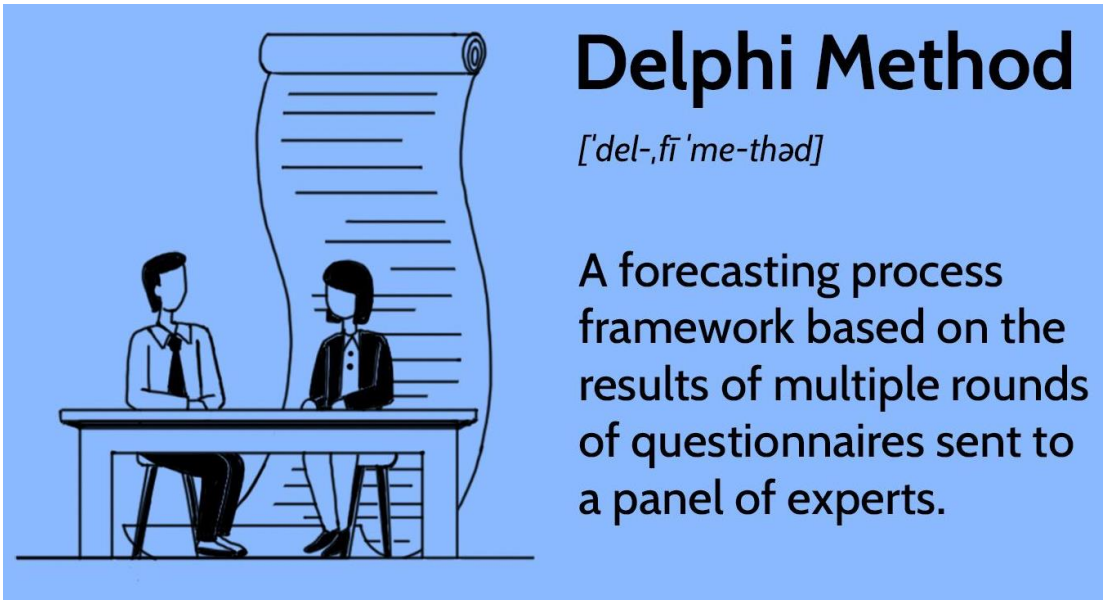

Figure 18. The definition of Delphi Method (Twin, 2024)

One of the key advantages of the Delphi approach is its iterative nature (Twin, 2024). Experts review and evaluate ideas anonymously across multiple rounds, which promotes unbiased input. Participants feel freer to offer candid assessments and refine their views once they see aggregated feedback in subsequent rounds, reducing the risk of conformity bias or the influence of a single dominant voice. The other advantage of the Delphi approach is its ability to cover complex topics through a structured process. Since CM/GC intersect multiple domains including project identification and selection, procurement, preconstruction, and project cost, Delphi approach could organize the feedback loop and ensure that each of these domains is addressed thoroughly.

10.2 Delphi Survey Procedure

According to the procedure provided by Rivière (2018), the standardized procedure of a Delphi survey consists of questionnaire in the beginning, analysis after the first round, reformulation of

questions based on analysis results, and other rounds for reevaluation. Based on the limited time for this project, the specific procedure for this study included five distinct phases, which are preparation and expert identification, survey process, data analysis, and incorporation of results into the report. Here is the table demonstrating the Delphi survey procedure (see Table 18).

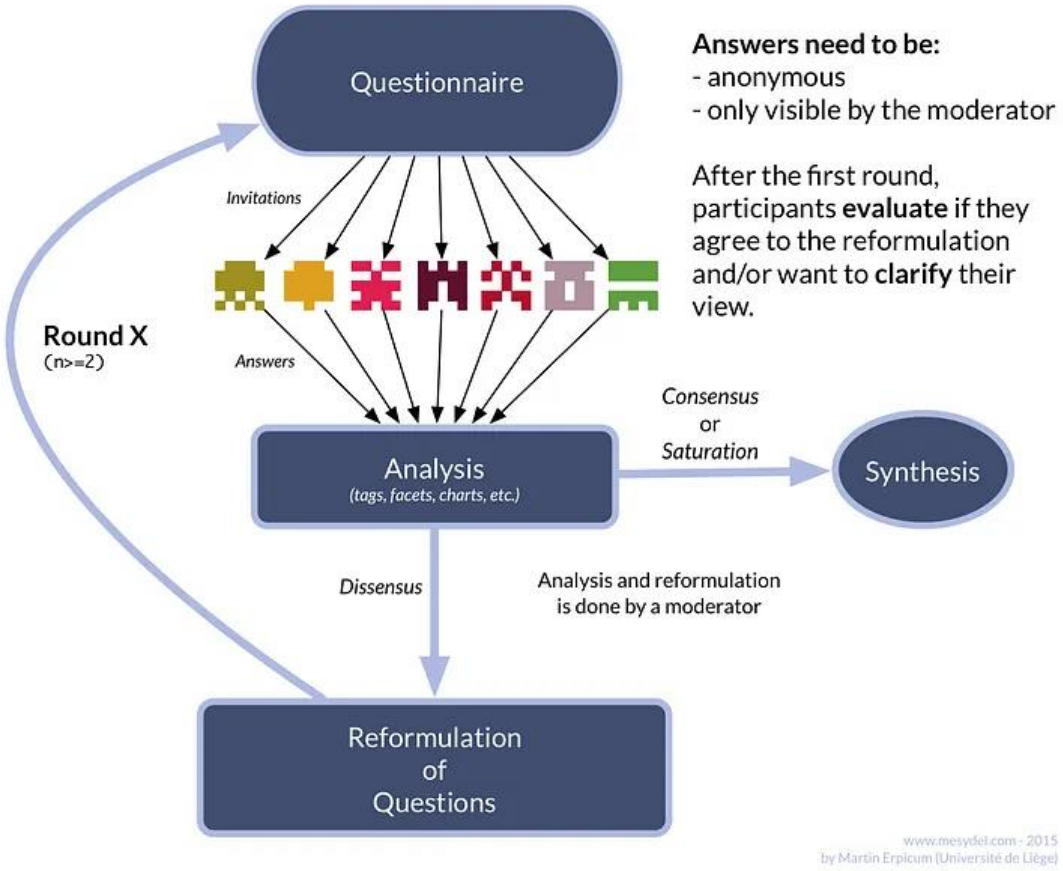

Figure 19. Delphi Survey Procedure provided by Rivière (2018)

Table 18. Delphi Survey Procedure specific for this project

Phase	**Activities**	**Timeframe**
Phase 1: Preparation & Expert Identification	- Identify and invite GDOT stakeholders to participate in the Delphi survey. - Finalize survey structure and initial questions based on literature review and preliminary discussions.	Week 1 (Jan 27th – Jan 31st)
Phase 2: Survey Process	- Distribute the initial survey to gather broad input on CM/GC procurement, preconstruction, and cost negotiation. - Participants provide responses to questions.	Week 2-3 (Feb 3rd – Feb 14th)
Phase 3: Data Analysis	- Analyze responses to identify common themes. - Develop structured questions for Round 2 based on expert feedback.	Week 4 (Feb 17th – Feb 21st)

Phase 4: Incorporation of Results into the Report	- Compile findings into a structured report with key takeaways for GDOT.	Week 5 (Feb 24th – Feb 28th)

At the beginning of the procedure, the research team have identified a diverse panel of GDOT and other DOT stakeholders, contractors, design consultants, and academic specialists. Based on the preliminary literature reviews and GDOT's CM/GC objectives, the research team crafted initial survey questions covering project identification, procurement, preconstruction services, and negotiated construction price. After that, the survey invitations were sent to the identified experts through emails, providing them with background information on GDOT's CM/GC transition. Participants rate various CM/GC best practices, explained their choices, and offered open-ended feedback on challenges or additional practices not yet identified. Then, response were synthesized to identify areas of clear consensus (e.g., universal agreement that "early contractor involvement is crucial) and points of divergence. Based on the survey data, follow-up questions or clarifications were developed to explore differing viewpoints or ambiguities in greater detail. At last, consensus or near consensus practices were flagged as high priority, while practices with continued divergence were documented with rationales and suggested conditions under which they might be effective. The most widely endorsed best practices as well as policy or implementation guidelines were compiled in this report.

10.3 Survey Content and Structure

Building on the core areas of CM/GC project delivery and GDOT's CM/GC manual, with the aid of Qualtrics platform, the survey was created into seven themed sections. Each section included both rating or prioritization questions using 5-point Likert scales and open-ended prompts for deeper insight. As for rating or prioritization questions, experts score the importance of different practices in section. These questions are asked in matrix table. As for questions regarding specific factors and reasons, experts are asked to provide their opinions regarding specific factors accounting for their selection of "extremely important" or "very important". These questions are asked in multiple choices or text input. As for open-ended questions, experts are asked to provide their insights on challenges and improvements for CM/GC implementation. These questions are asked in text input. Here is a diagram showing the entire structure of the Delphi survey (see Figure 20 and Figure 21).

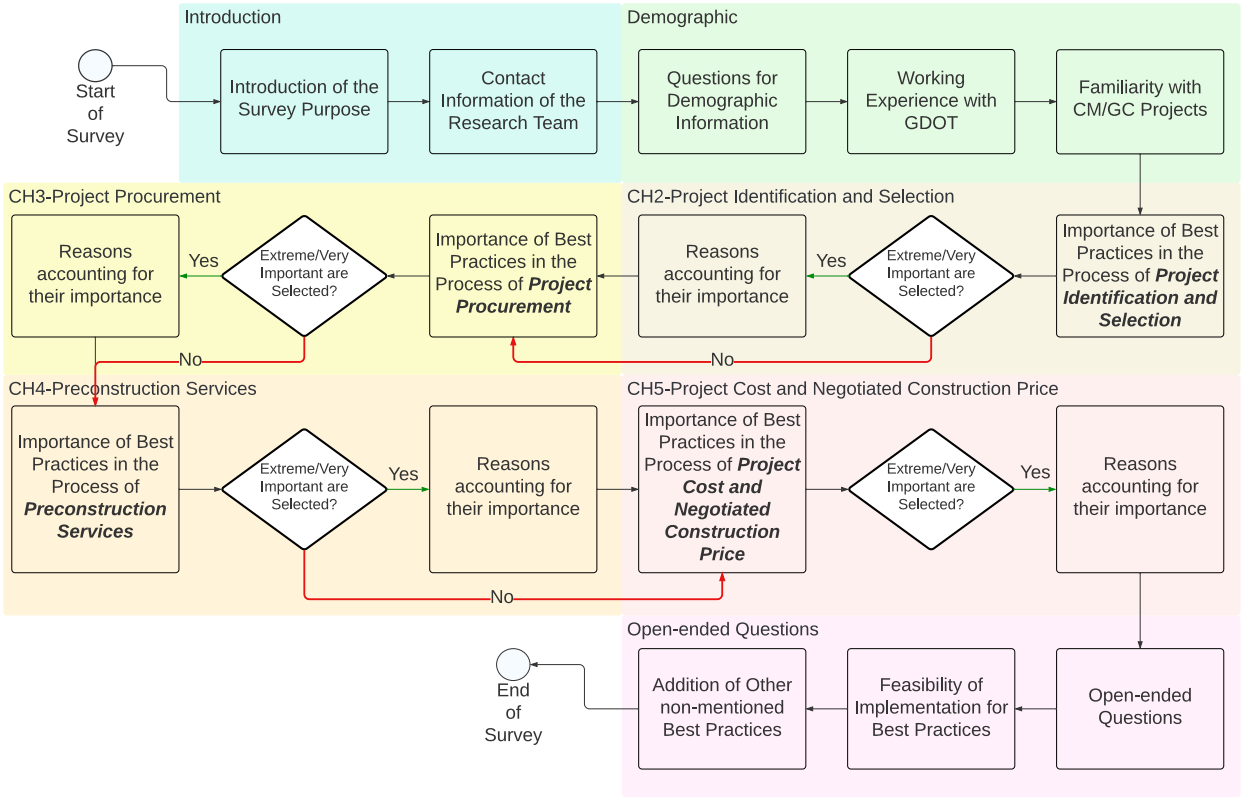

Figure 20. Delphi Survey Content and Structure

In the first section "Introduction", the purpose of the research, explanation of how response would inform GDOT's adoption of CM/GC, as well as the consent form are presented to participants. Followed by "Demographics" section, participants' roles within GDOT and other

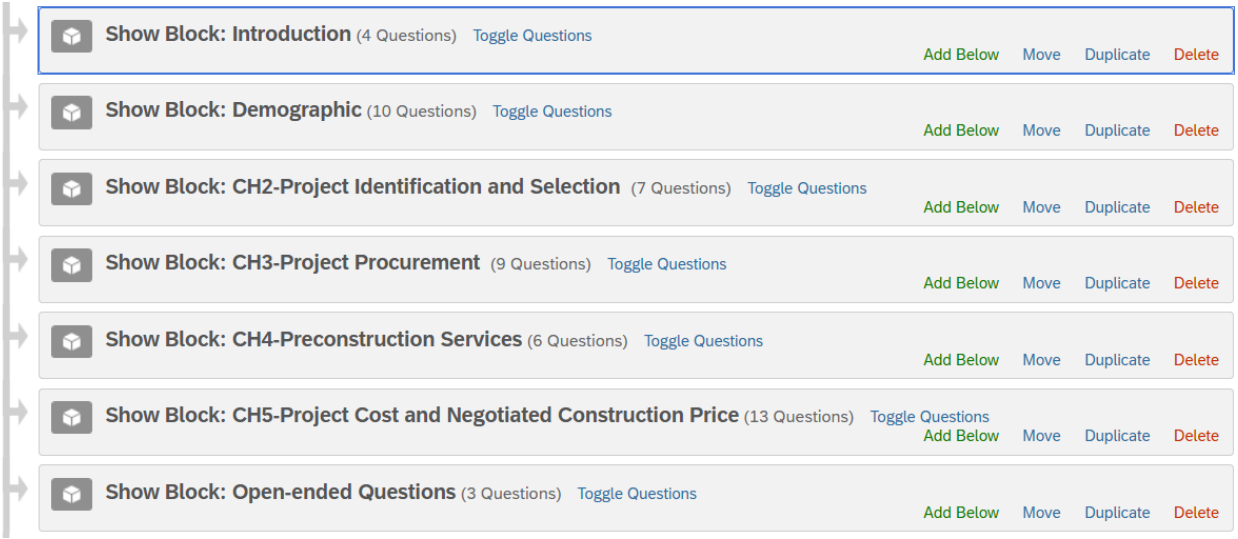

Figure 21. Survey Flow of the Delphi Approach

DOTs, years of experience, previous involvement in CM/GD projects, and self-assessment of familiarity with the CM/GC method are asked. Next, four sections which focus on each chapter

mentioned before in the best practice framework respectively are following. If participants select "extreme important" or "very important" for specific best practices, they are asked to clarify their reasons accounting for their importance. In the end, the "Open-ended Questions" offers a place to provide solicited feedback on non-feasible practices and opportunities for new or unmentioned best practices. This logical and structured flow ensures that participants could comprehensively address each major phase of CM/GC delivery, from deciding whether CM/GC is the right approach to procurement mechanics, preconstruction collaboration, and cost negotiations.

10.4 Data Analysis of Survey Responses

After collecting the survey responses through Qualtrics platform, the data was analyzed using a combination of qualitative and quantitative approach. This dual framework ensures that both numerical ratings and rich, open-ended inputs were effectively interpreted to yield actionable insights for GDOT's CM/GC best practices.

Quantitative Integration

All the closed ended (rating) responses from the survey were gathered into a structured database for statistical examination. Each best practice, whether related to project identification, procurement, preconstruction services, or cost negotiation, was rated on a Likert scale (from "Not at all important" to "Extremely important"). The core statistical metrics calculated included ***Mean Scores***, ***Median and Distribution***, and ***Standard Deviation***. ***Mean Scores*** provided an overall sense of how strongly participants felt about each practice. ***Median and Distribution*** helped identify any skew in responses, especially if opinions were polarized or if there was a strong majority of inclination. ***Standard Deviation*** showed how much variability existed within the ratings and signaled whether participants generally agreed or diverged in their views. From these metrics, particularly high-scoring or broadly agreed-upon practices emerged as potential consensus items. Practices which averaged near the top of the scale were flagged for deeper scrutiny in subsequent round 2 for potential inclusion in GDOT's best practices summarization.

Qualitative Integration

In addition to the numeric data, open-ended responses added context and depth. These text-based comments were systematically reviewed and coded to identify major themes. For example, if "early cost modeling" or "digital collaboration tools" were mentioned repeatedly by many experts, these references signaled a strong emphasis on those methods or techniques. These qualitative findings could help clarify why certain practices scored high or low in the quantitative ratings and shed light on the specific strategies or resource needs experts believed were essential for successful CM/GC adoption.

Identification of Consensus

To formalize the notion of consensus, a cutoff threshold was set, generally at 70% approval. This means at least 70% of participants rated a practice as "very important" or "extremely important." Any practice meeting or surpassing this benchmark was deemed to reach a strong consensus. However, the Delphi survey also revealed some innovative practices favored by a smaller but vocal group of participants. Although these emerging ideas were noted as promising, they might require additional pilot testing or more robust discussion to confirm broad viability.

All the consensus and emerging practices identified through the process were synthesized into this report. This deliverable included pragmatic guidelines (e.g., how to implement early contractor involvement), policy considerations (e.g., recommended contract terms or incentive structures), and training modules (e.g., recommended skill sets for procurement committees). By integrating both data-driven insights and expert commentary, the Delphi analysis yielded a thorough, context-rich roadmap to help GDOT enhance its CM/GC project delivery strategy.

10.5 Summary of Findings and Indications

Building on the Delphi process outlined in Sections 10.1 to 10.4, the survey results provided a substantial dataset which illustrates both consensus points and area of divergence regarding CM/GC best practices for GDOT. This section integrates key quantitative and qualitative insights from the survey responses, offering an overarching perspective on which practices are widely endorsed by practitioners and where further clarification might be needed. Ultimately, these findings could guide GDOT in refining its CM/GC framework, particularly in selecting, procuring, and executing CM/GC projects under varying levels of risk and complexity.

Participant Demographics and Overall Perceptions

A total of nine respondents completed the survey, representing a spectrum of roles primarily within GDOT (6 responses) and other DOTs (3 responses), including project managers, engineers, and owner/client representatives. Most participants had more than 10 years of transportation industry experience, and the majority indicated they had been involved in at least one CM/GC project (see Figure 22). When asked to rate familiarity with the CM/GC method (on a scale of 1 to 5), the mean score was 3.38, reflecting a moderate to high level of familiarity. This participant profile suggests that the collected feedback originates from seasoned professionals with practical exposure to collaborative delivery methods.

Regarding the perceived effectiveness of CM/GC, risk mitigation received the highest rating (mean 4.33), while cost efficiency scored somewhat lower (mean 3.11). Taken together, these scores suggest that respondents recognize CM/GC's ability to manage complex project risks effectively but remain cautious about whether cost advantages are fully realized in all CM/GC contexts. Overall project quality also scored highly (mean 4.00), reinforcing the notion that early contractor involvement and collaborative risk management could improve final deliverables and project outcomes (see Figure 23).

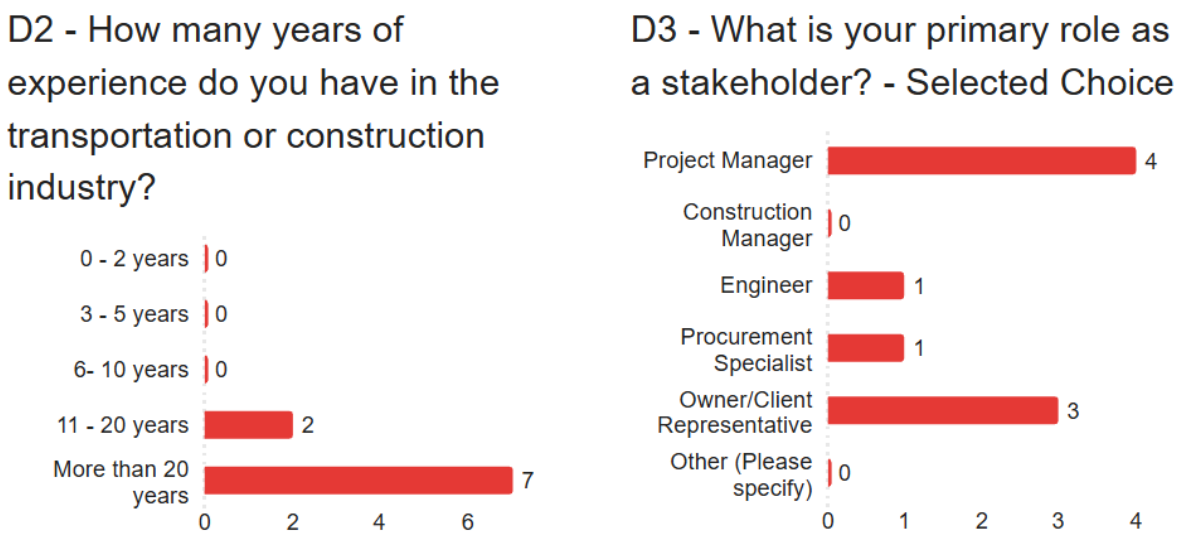

Figure 22. Years of experience and stakeholder role of survey participants

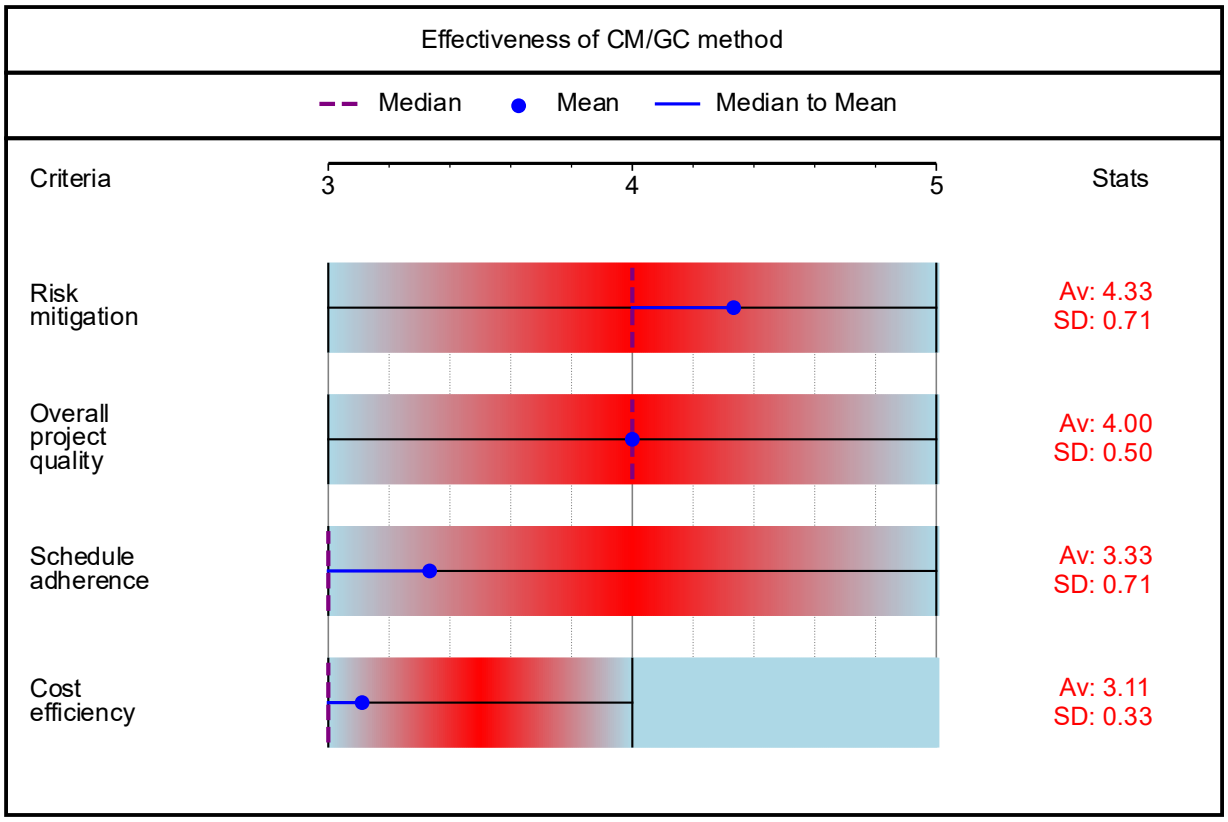

Figure 23. Perceived effectiveness of CM/GC from survey participants

Consensus on Project Identification and Selection

The core rating question in this chapter (CH2-2) invited respondents to score six best practices for project identification and selection: (1) Assessment of project complexity and risk, (2) Alignment with project requirements, (3) Early contractor involvement, (4) Stakeholder collaboration and

goal alignment, (5) Regulatory and legislative considerations, and (6) Comprehensive evaluation of proposals. Among these, ***Assessment of Project Complexity and Risk*** and ***Early Contractor Involvement*** both attained a high mean rating of 4.67, underscoring the perceived necessity of thorough risk evaluation and early engagement of construction expertise. ***Comprehensive Evaluation of Proposals*** also received a relatively strong endorsement at 4.33, reflecting a consensus that multiple criteria, beyond cost alone, must be considered into determining whether a project is suited to CM/GC delivery (see Figure 24).

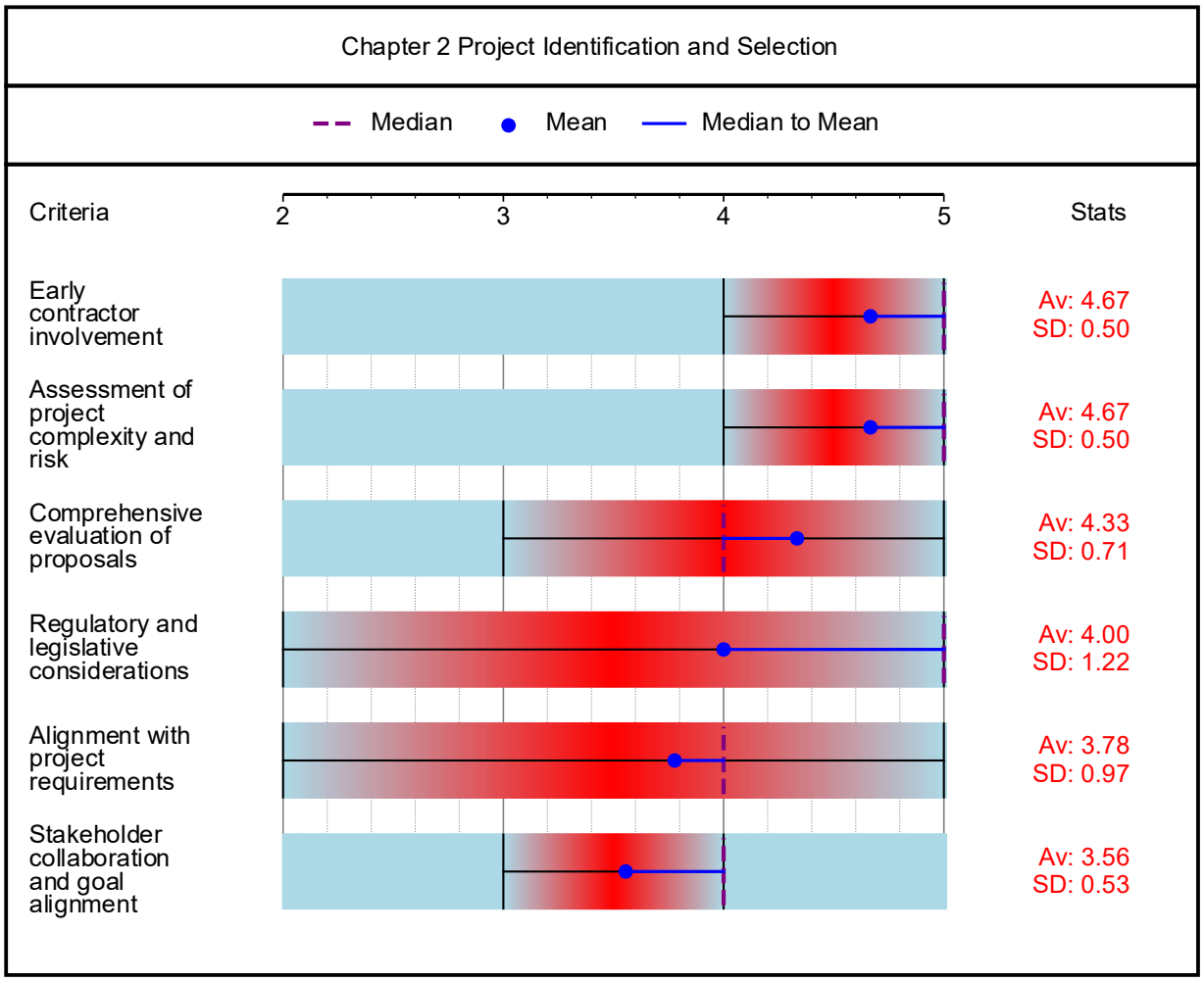

Figure 24. Perceived importance of best practices in the process of project identification and selection from survey responses

Follow-up questions provided further insight. Several collaborative risk assessment tools are favored by participants, including risk registers, matrix-based scoring, and early-stage mitigation workshops. Several stressed that ***commencing risk management as early as possible*** is vital, particularly when the aim is to tailor design decisions to actual project conditions. Moreover, the majority of participants cited ***Technical Demands*** and ***Budget Constraints*** when deciding CM/GC aligns with a project's financial and scheduling goals (see Figure 25). In the next question, respondents emphasized the chief benefits of early contactor involvement as ***Enhanced Constructability Reviews*** and ***Better Risk Identification and Mitigation*** (see Figure 26).

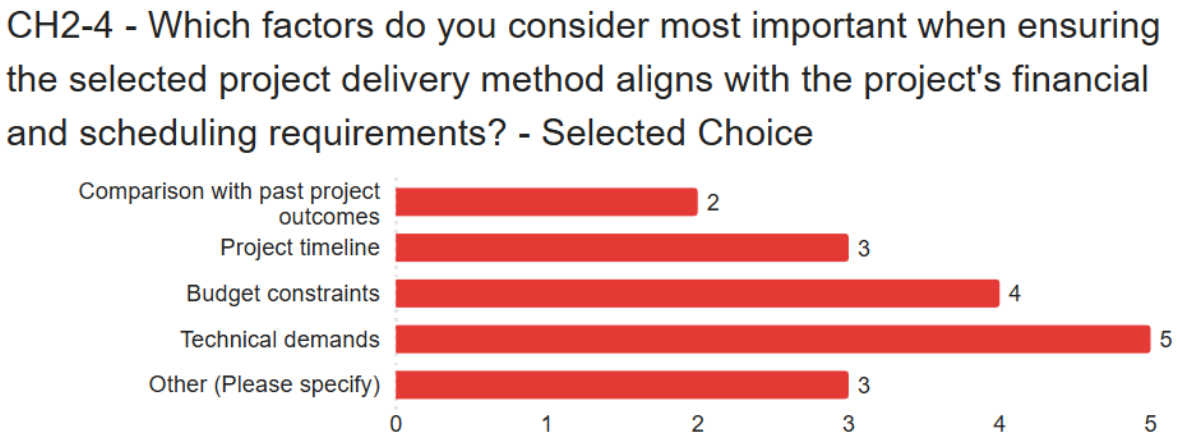

Figure 25. Perceived factors regarding alignment of project's financial and scheduling requirements from survey responses

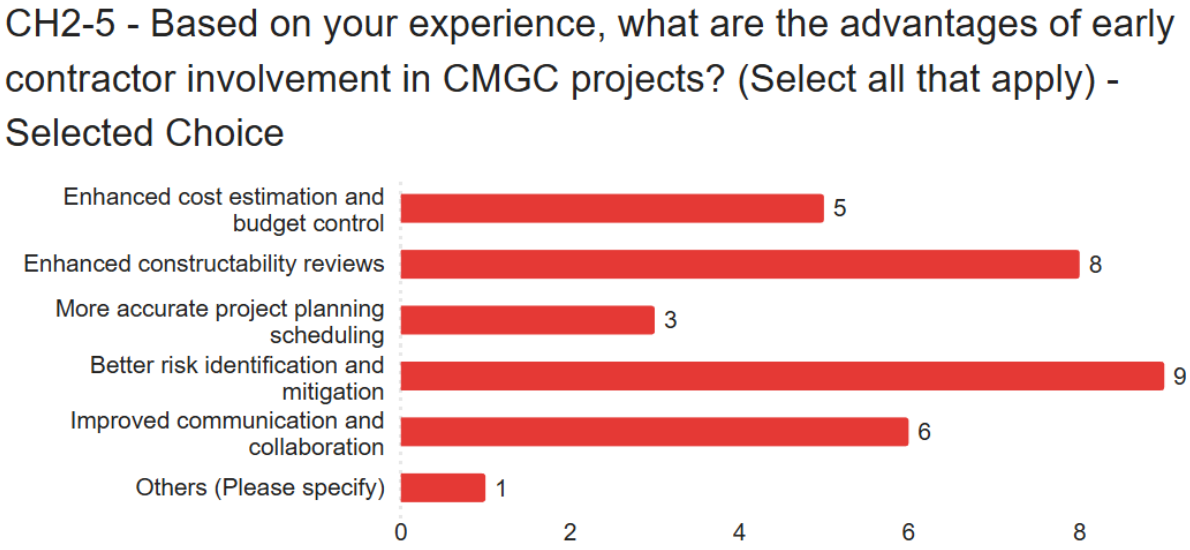

Figure 26. Perceived advantages of early contractor involvement in CM/GC projects from survey responses

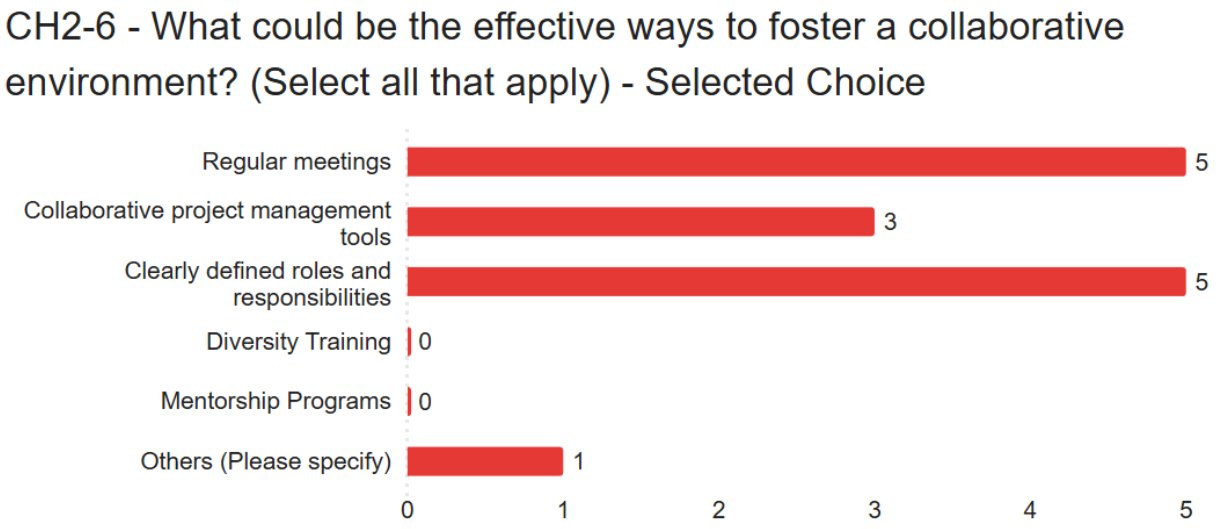

Figure 27. Perceived effective ways to foster collaborative environment from survey responses

Furthermore, as for practical collaboration mechanisms, ***Regular Meetings*** and ***Well-defined roles*** are suggested by participants, highlighting the importance of formal processes rather than passive cooperation to ensure stakeholder alignment (see Figure 27). Altogether, this chapter's data affirm that participants see CM/GC as particularly advantageous when projects exhibit moderate to high complexity, involve intricate risks, or demand specialized contractor input.

Procurement Preferences and Key Debates

As for procurement preferences, the survey asked respondents to rate the best practices in the CM/GC procurement process, focusing on: (1) Early selection of the construction manager, (2) Verification and education in the CM/GC process, (3) Utilization of best-value (BV) procurement, (4) Training for the evaluation committee, (5) Detailed evaluation and debriefings, and (6) Assessment of QBS (qualifications-based selection) over best-value procurement. ***Early Selection of the Construction Manager*** and ***Assessment of QBS over Best-Value Procurement*** both attained high mean values of 4.12, while ***Training for the Evaluation Committee*** received an average of 4.00 (see Figure 28). These results suggest that respondents believe it's both necessary to involve a qualified construction manager in early design stages and to ensure that the individuals who select this contractor are well-trained to evaluate complex proposals.

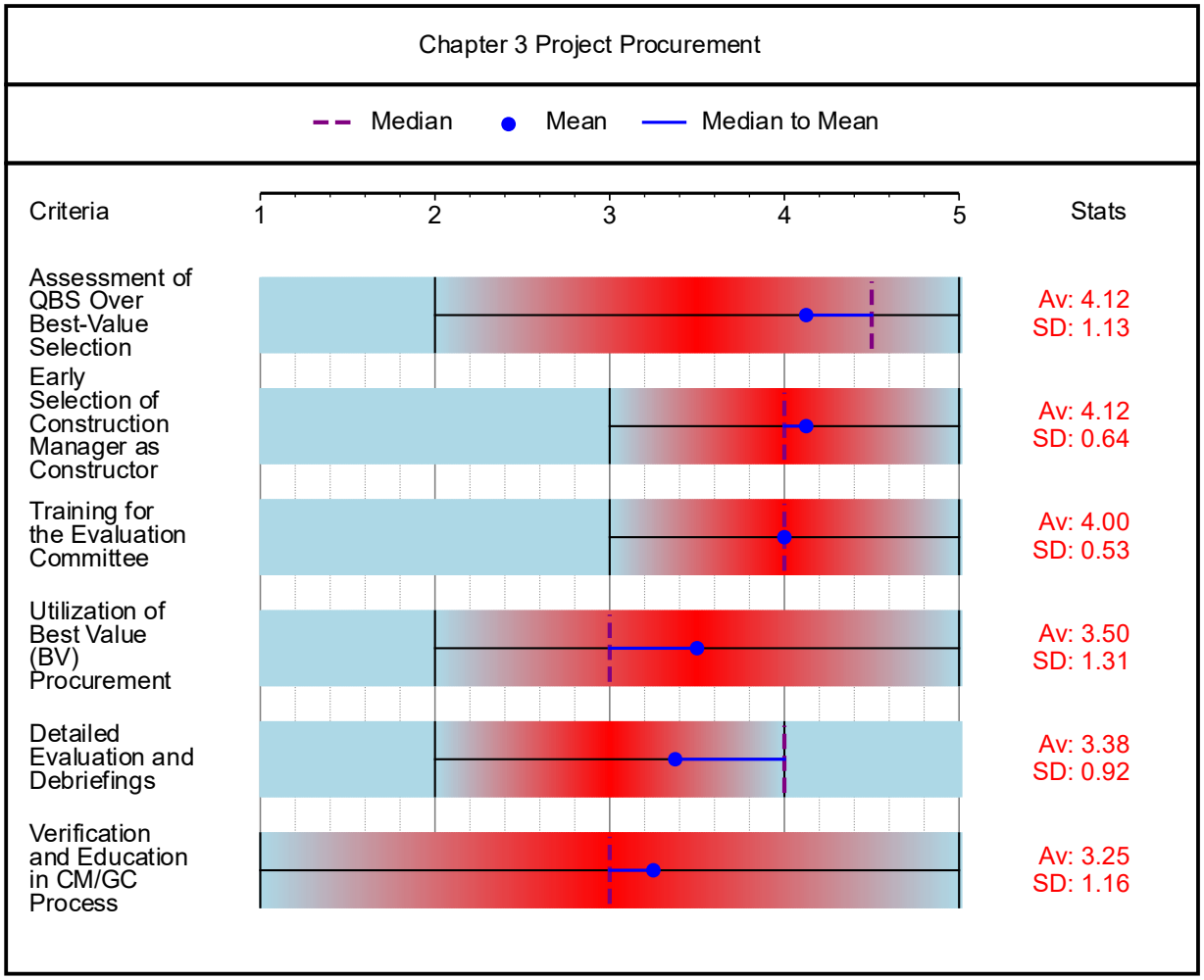

Figure 28. Perceived importance of best practices in the process of procurement from survey responses

Supporting questions followed explored the rationale behind these preferences. In question CH3-3, the majority of respondents stated that selecting a CM early helps ***refine design decisions*** and ***reduce downstream constructability issues*** (see Figure 29). A few cautioned that extremely early selection may raise costs if the design is not sufficiently advanced, though they still generally favored employing CM expertise well before final construction documents. CH3-4 revealed that participants primarily ***verify the contractors' track record*** and ***personnel qualifications***, rather than devoting extensive effort to educating stakeholders on GMP negotiations (see Figure 30). This finding might imply that, in practice, seasoned contractors and owners require less formal education on core CM/GC procedures. Finally, CH3-5 illustrated the ***preference for QBS over best-value procurement***, with six out of eight participants indicating that cost is difficult to evaluate meaningfully when design is below approximately 60% completion (see Figure 31). Nevertheless, the minority who supported best-value procurement noted that a price component can help keep the owner's budgetary objectives on the table, although they recognized potential pitfalls in awarding too much weight to cost at an early design stage.

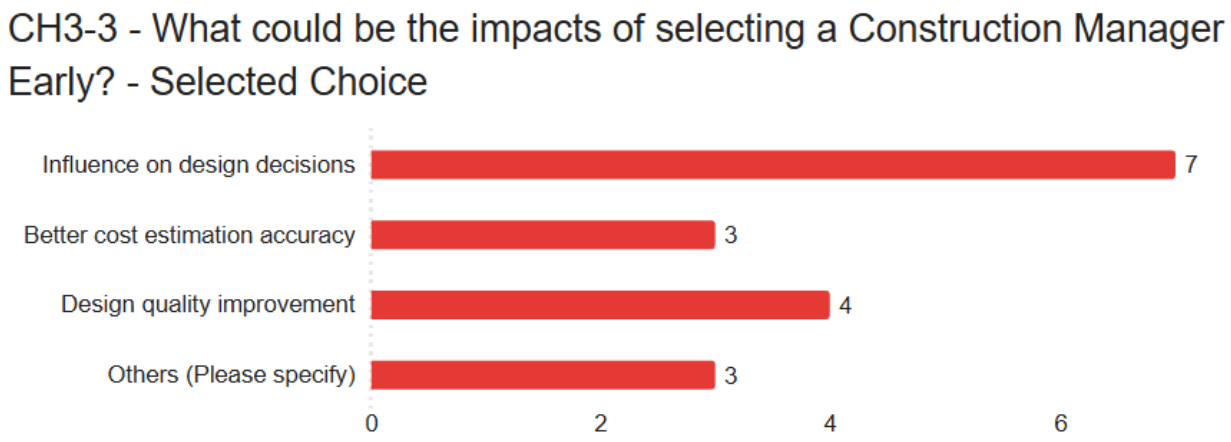

Figure 29. Perceived impacts of selecting a construction manager early from survey responses

Figure 30. Perceived factors under consideration for verification and education from survey responses

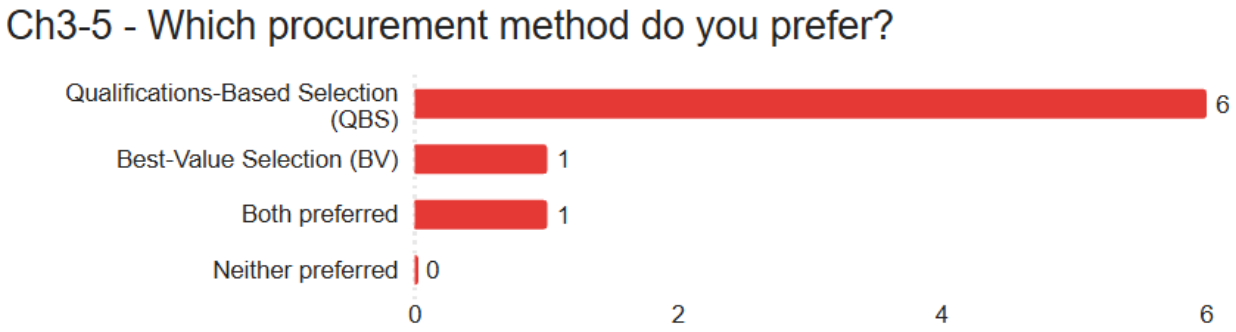

Figure 31. Preferred procurement method from survey responses

Preconstruction Emphasis on Constructability, Scheduling, and Risk

Regarding preconstruction process, respondents rated five best practices: (1) Early engagement of construction managers, (2) Risk management and sustainability practices, (3) Scheduling for all project phases, (4) Value optimization and resource allocation, and (5) Conducting constructability reviews. Among these, ***Conducting Constructability Reviews*** achieved the highest mean rating of 4.50, consistent with the view that a core strength of CM/GC lies in leveraging contractor expertise

to verify design feasibility and reduce costly revisions. ***Risk Management and Sustainability Practices*** closely followed at 4.12, reinforcing the survey's broader trend that systematic risk assessment remains integral to participants' vision for CM/GC (see Figure 32).

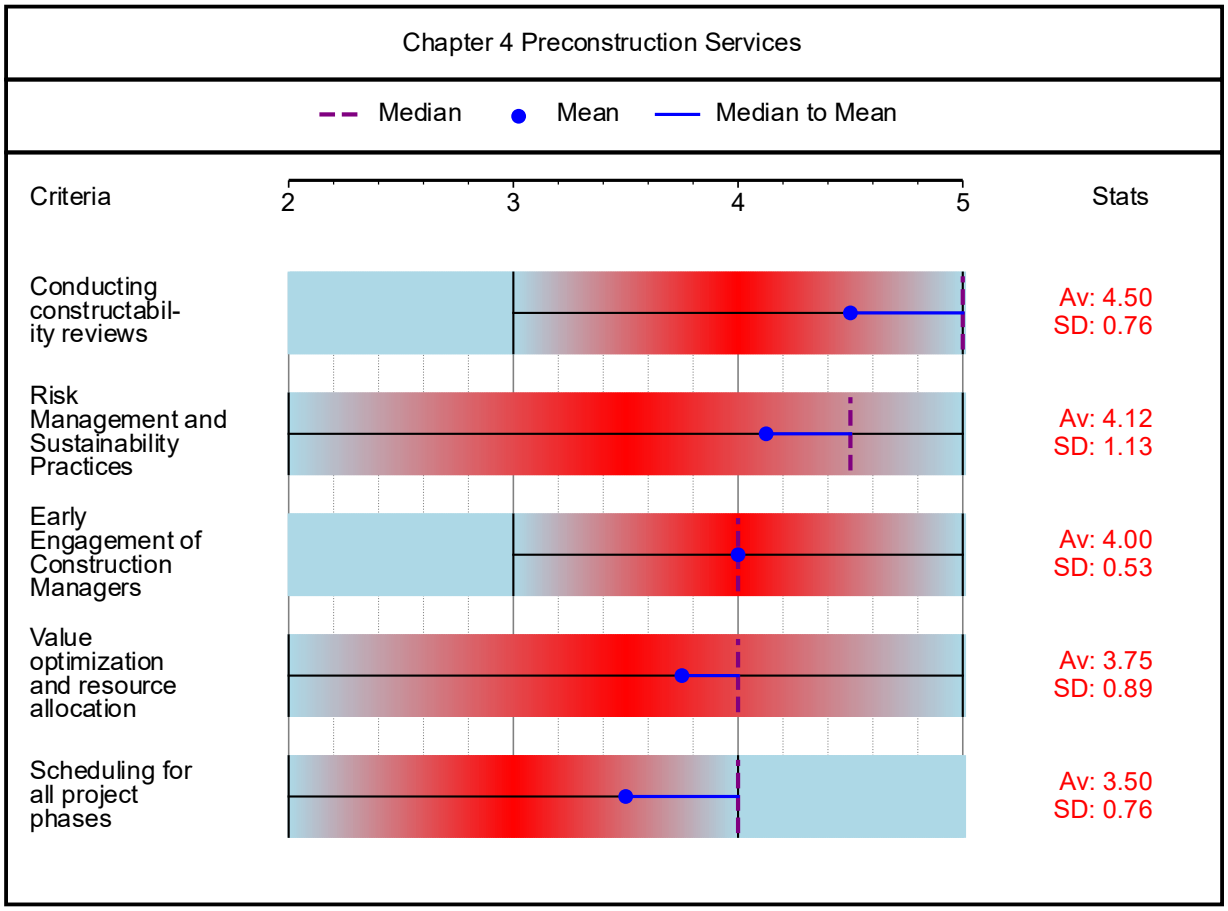

Figure 32. Perceived importance of best practices in the process of preconstruction from survey responses

The chapter's supporting questions highlighted further details. CH4-3 revealed that ***Risk Registers*** and M***atrix-based Analysis*** again featured prominently, emphasizing the quantitative underpinnings of effective risk management. Respondents in CH4-4 stressed the importance of ***dynamic scheduling software*** and ***milestone tracking*** to maintain realistic timelines, with one respondent noting that major design progression points (e.g., 30%, 60%, 90%) require dedicated resources (see Figure 33).

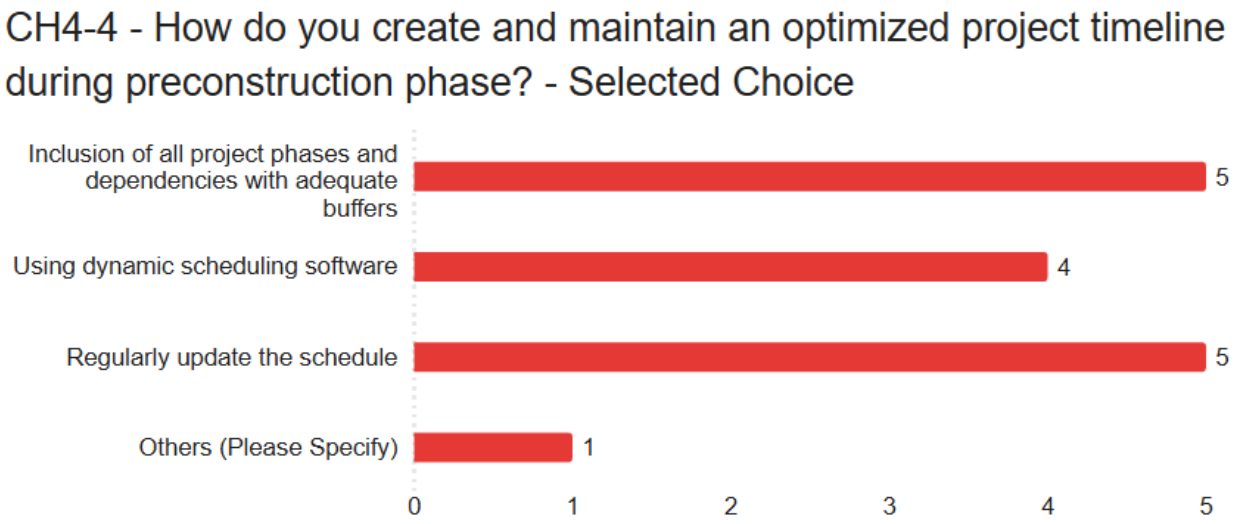

Figure 33. Perceived method for optimizing project timeline during preconstruction phase from survey responses

CH4-5 indicated a modest preference for ***subdividing complex projects into work packages*** as a means of optimizing resource allocation, allowing teams to work in parallel on design and preconstruction tasks (see Figure 34). Overall, the responses in this chapter underscore how formal risk modeling, rigorous constructability reviews, and iterative scheduling frameworks collectively define a robust preconstruction phase for CM/GC.

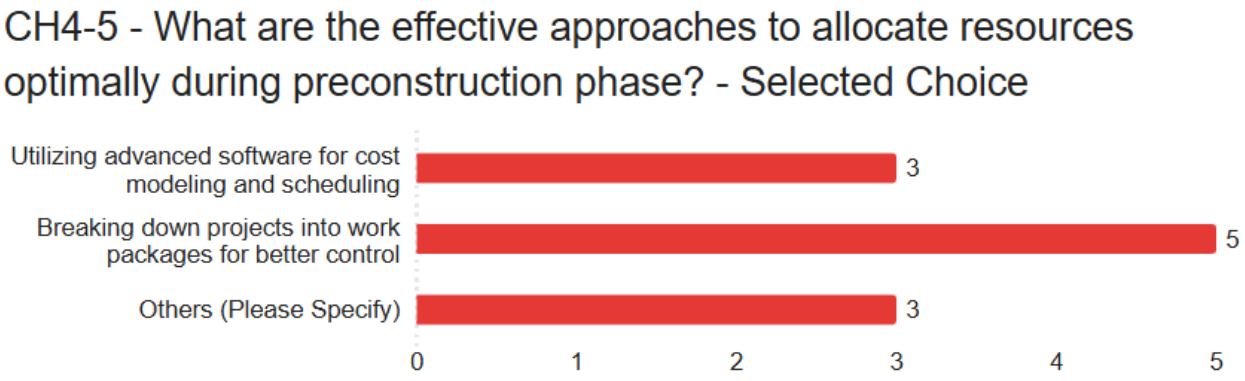

Figure 34. Perceived effective approaches to allocate resources optimally during preconstruction phase from survey responses

Cost Control, Pricing Models, and Independent Cost Estimators

In terms of cost control and estimation, participants were asked to evaluate six best practices: (1) Utilizing guaranteed maximum price (GMP) contracts, (2) Employing independent cost estimators (ICEs), (3) Incentive clauses for cost savings, (4) Progressive GMP for phased projects, (5) Regular price reviews, and (6) Transparent communication and documentation. Notably, Employing Independent Cost Estimators scored a perfect 5.00, reflecting unanimous support for having a neutral third party evaluate the contractor's price proposals. ***Regular Price Reviews*** and ***Transparent Communication and Documentation*** also received strong endorsement, 4.25 and 4.38 respectively, further indicating that participants value iterative, open-book checks on the project budget (see Figure 35).

Several challenges emerged, though, around incentives and progressive GMP. Supporting questions CH5-3 revealed mixed attitudes toward GMP contracts themselves, with some participants considering GMP as an effective budget cap and others deeming it premature if design remains fluid (see Figure 36). Incentive clauses (2.62) and progressive GMP (2.75) both scored below 3.00, suggesting widespread hesitation. Many respondents worried that such measures could be "gamed" by contractors or prove cumbersome to administer unless supported by rigorous checks, robust scopes, and thorough risk registers. CH5-11 and CH5-12 additionally confirmed that cost-savings incentives attracted skepticism, with participants pointing out that contractors could artificially inflate initial cost estimates and later "create" savings (see Figure 37).

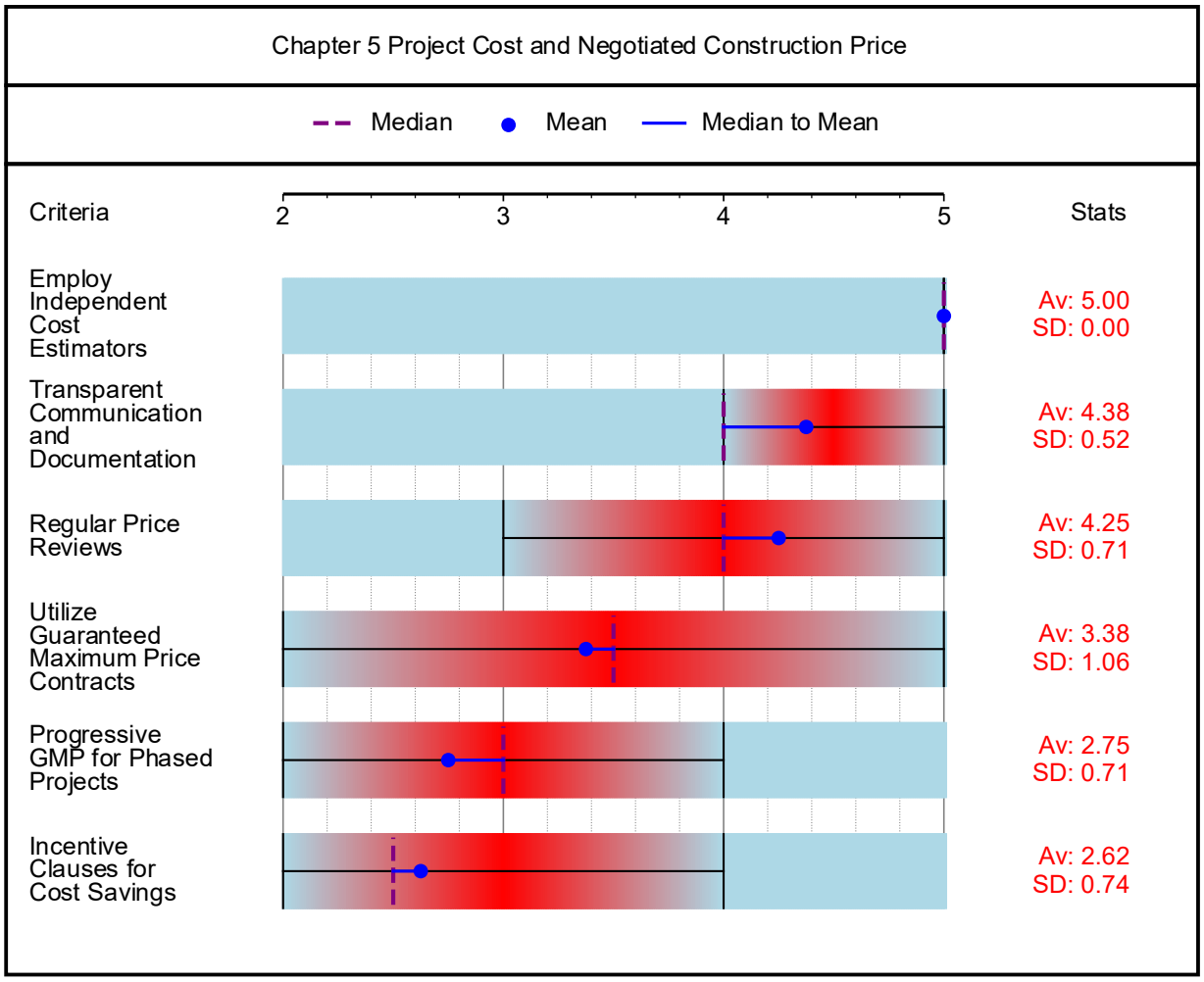

Figure 35. Perceived importance of best practices in project costs and negotiated construction price from survey responses

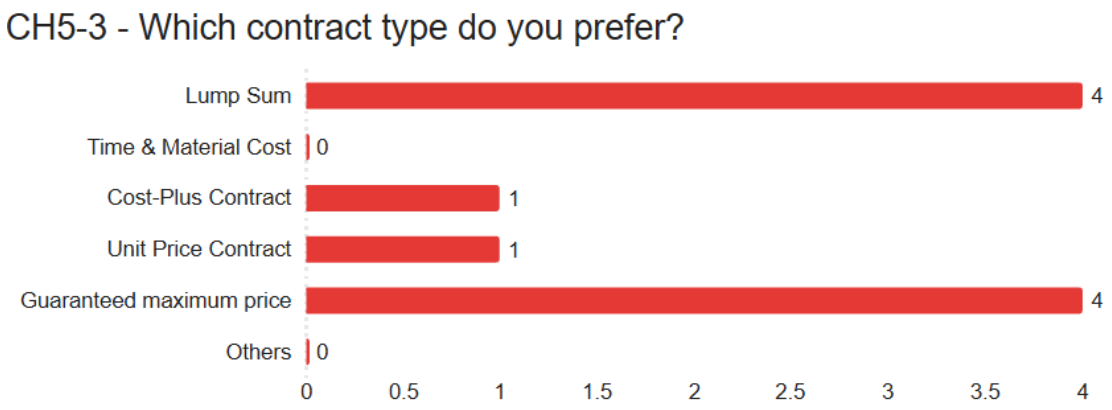

Figure 36. Preferred contract types among participants from survey responses

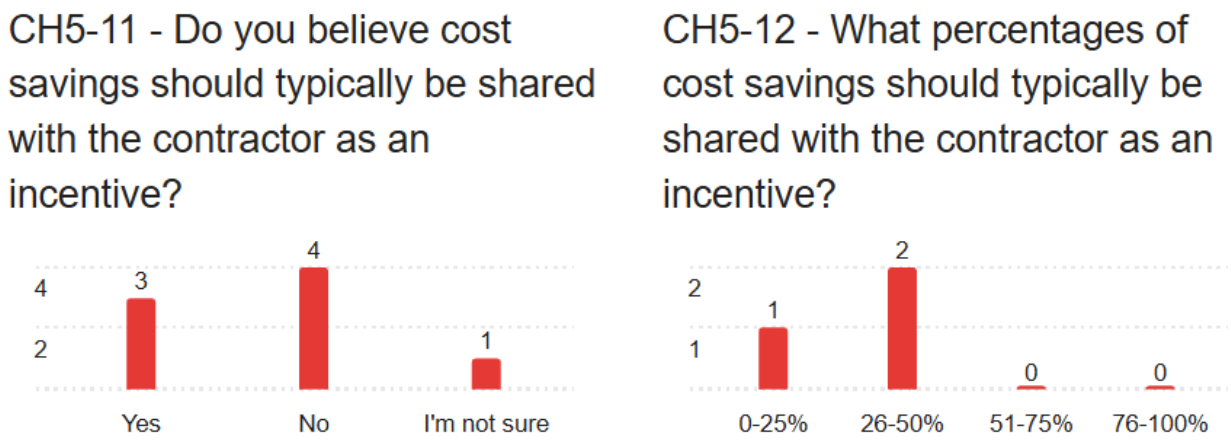

Figure 37. Evidence showing concern about cost-savings incentives could attract skepticism

Feasibility Concerns and Suggested Improvements

When asked which practices might be challenging to implement in Open-ended Question OQ2, respondents most frequently highlighted progressive GMP, scheduling for all project phases, and incentive clauses. Despite recognizing the potential value of these strategies, participants emphasized that their success hinges on ***precise scoping*** , ***well-established risk protocols***, and ***adequately trained personnel to oversee them***. Several respondents also warned that any perceived complexity or administrative burden could offset the collaborative advantages of CM/GC (see Figure 38).

OQ2 - Which Best Practices mentioned in this survey do you think is NOT feasible or difficult to implement? (Please refer to the diagram below)

Figure 38. Word cloud regarding feasibility of mentioned best practices from survey responses

Participants also offered additional feedback in Open-ended Question OQ3, advocating for progressive design-build in certain instances where the CM/GC model may not be the most practical fit. Others underscored the human element, emphasizing that collaborative project delivery fundamentally relies on having an experienced, communicative, and adaptable CM/GC team. Robust documentation of risks, scope, and design decisions was also cited as a critical enabler of smooth project transitions from preconstruction to execution.

Indications for GDOT Implementation

In conclusion, the survey data suggest that respondents overwhelmingly favor strong risk-based selection of CM/GC projects, early contractor involvement (especially for complex undertakings), and ongoing independent cost reviews throughout preconstruction. Qualitative feedback clarifies that while participants appreciate collaborative cost and schedule review, they hold concerns about advanced cost-sharing models, such as incentive clauses and progressive GMP. Instead, they see well-defined scopes, systematic risk management, and properly trained evaluation teams as the primary drivers of successful CM/GC outcomes. Based on these findings, GDOT CM/GC program might wish to formalize guidelines around the following:

1. ***Comprehensive Early Risk Assessment***: To ensure CM/GC is reserved for high-complexity, high stakes projects.
2. ***Qualifications-Based Selection Emphasis***: To facilitate robust contractor vetting and reduce reliance on incomplete cost data.
3. ***Structured Preconstruction Practices***: Incorporate constructability reviews, iterative scheduling, and risk workshops at every major design milestone.
4. ***Independent Cost Estimation and Transparent Price Negotiations***: Control budget and verity contractor proposals as using a near-universal mechanism.

Collectively, these Rounn 1 survey results affirm CM/GC's perceived strengths, namely risk management, early collaboration, and improved quality. Also, they highlight the areas wherein GDOT could refine or selectively pilot advanced cost and risk-sharing approaches.

11. CM/GC IMPLEMENTATION STRATEGY FOR GDOT

This roadmap provides a structured, decision-driven implementation plan for GDOT to enhance its CM/GC project delivery (see Figure 39, Figure 40, Figure 41, Figure 42, Figure 43, and Figure 44).

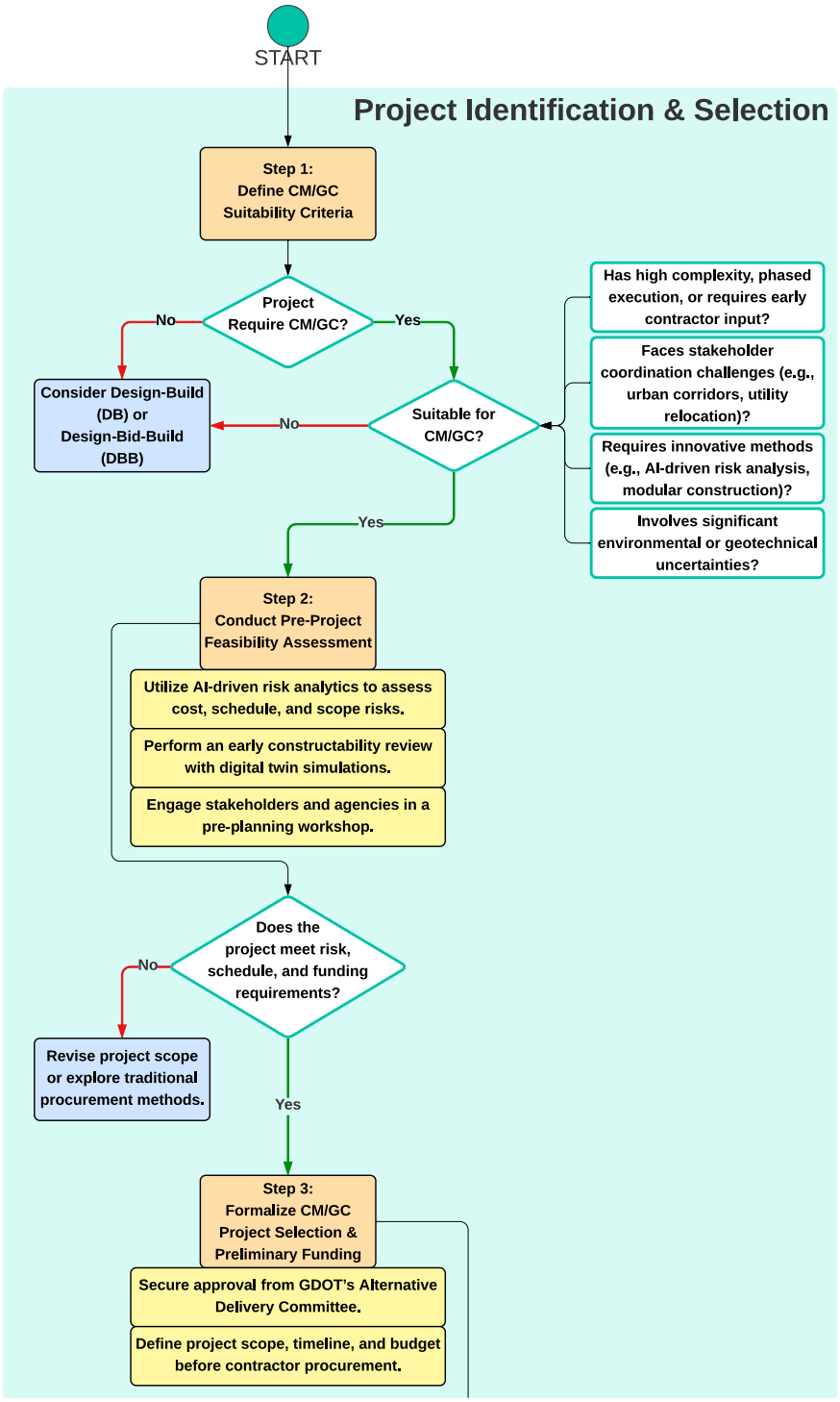

Figure 39. Section 1 of the Roadmap: Project Identification & Selection

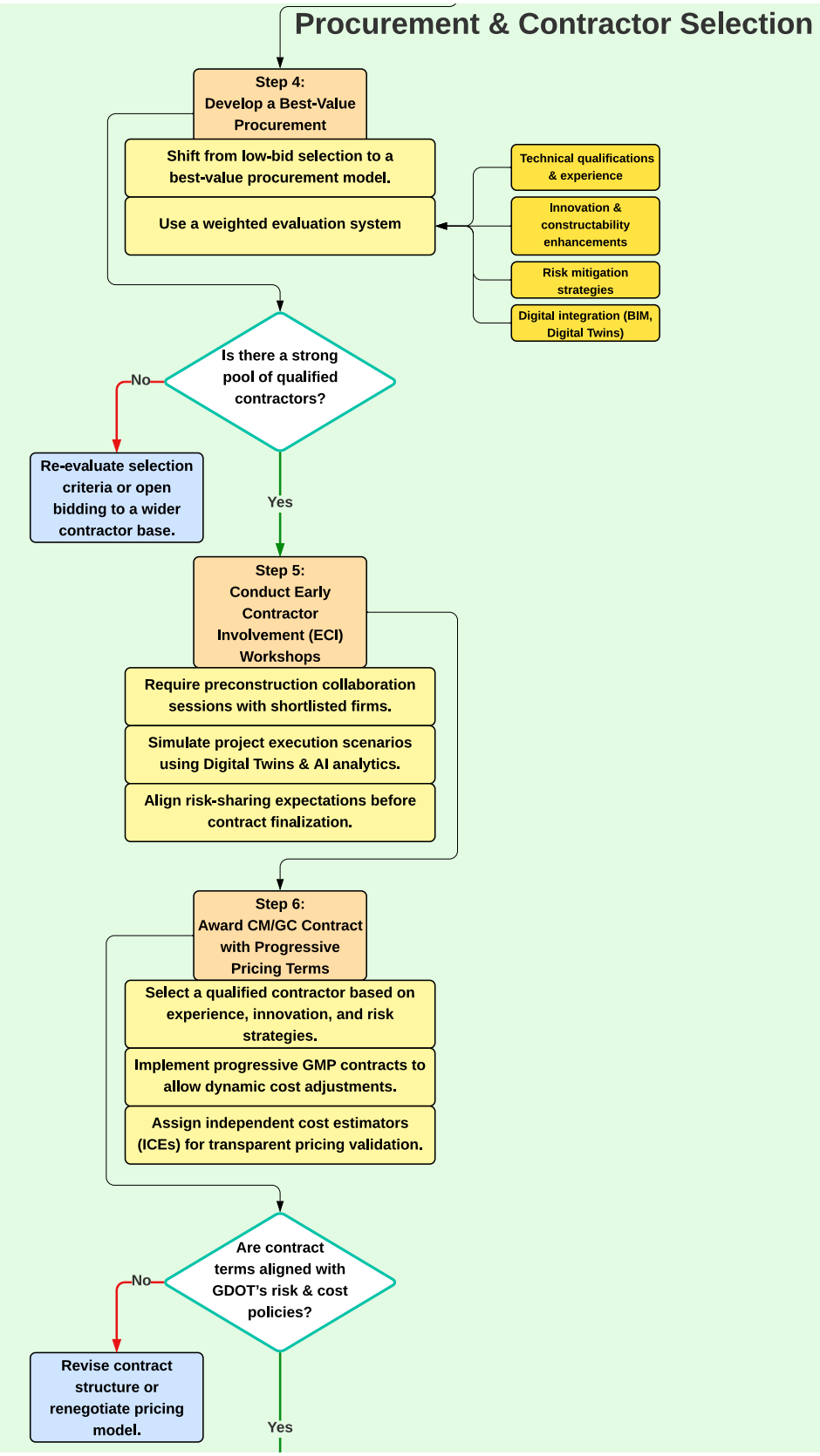

Figure 40. Section 2 of the Roadmap: Procurement & Contractor Selection

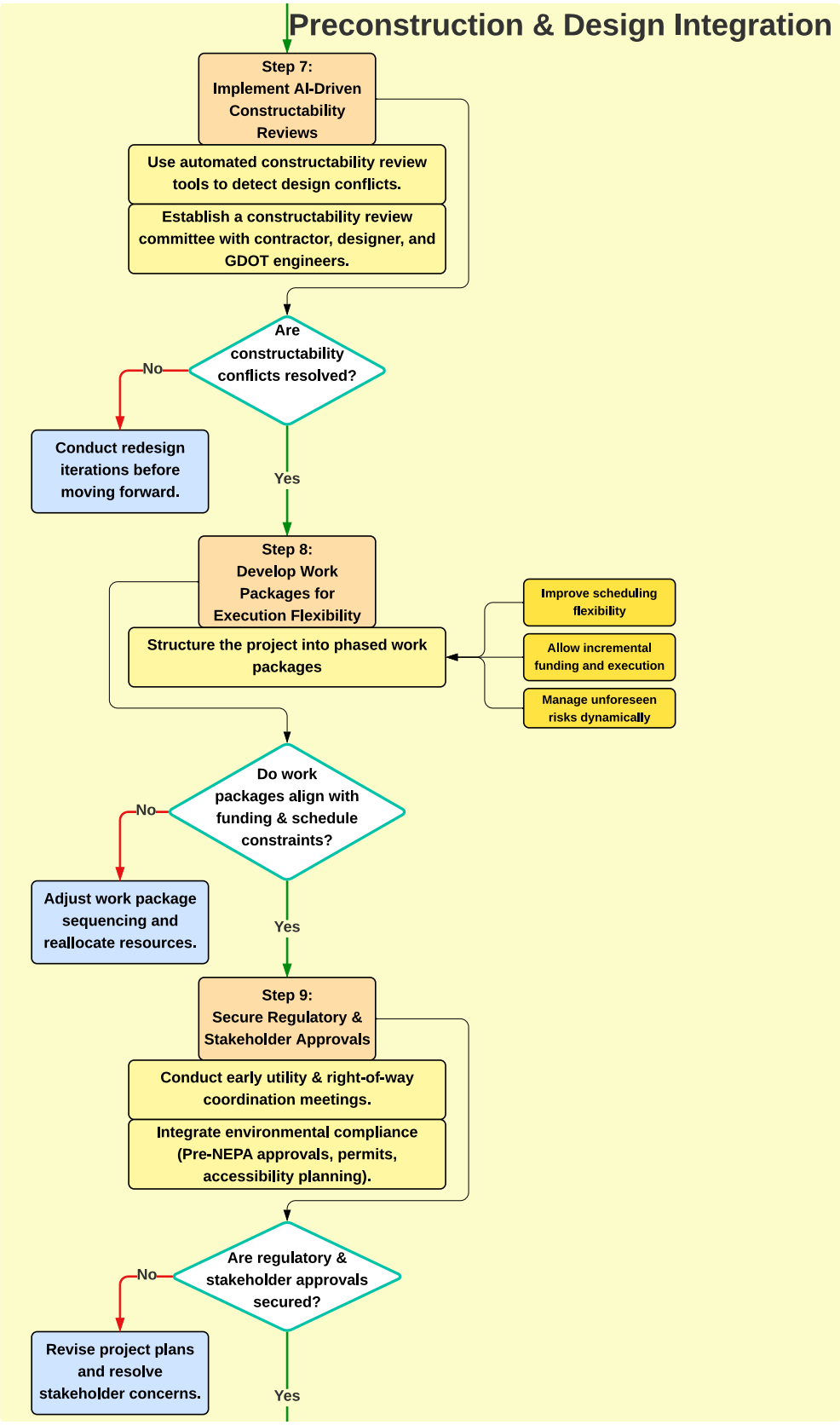

Figure 41. Section 3 of the Roadmap: Preconstruction & Design Integration

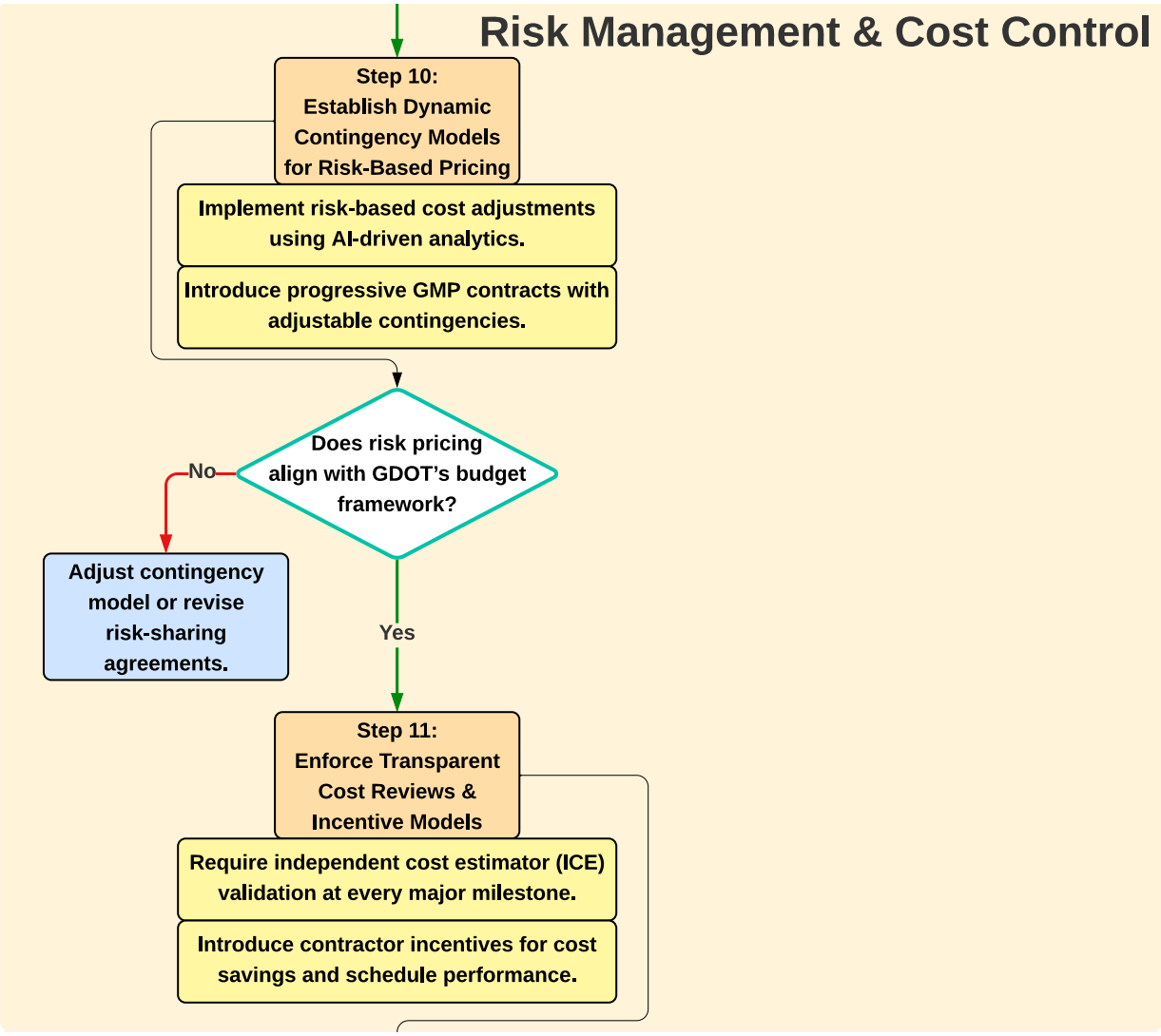

Figure 42. Section 4 of the Roadmap: Risk Management & Cost Control

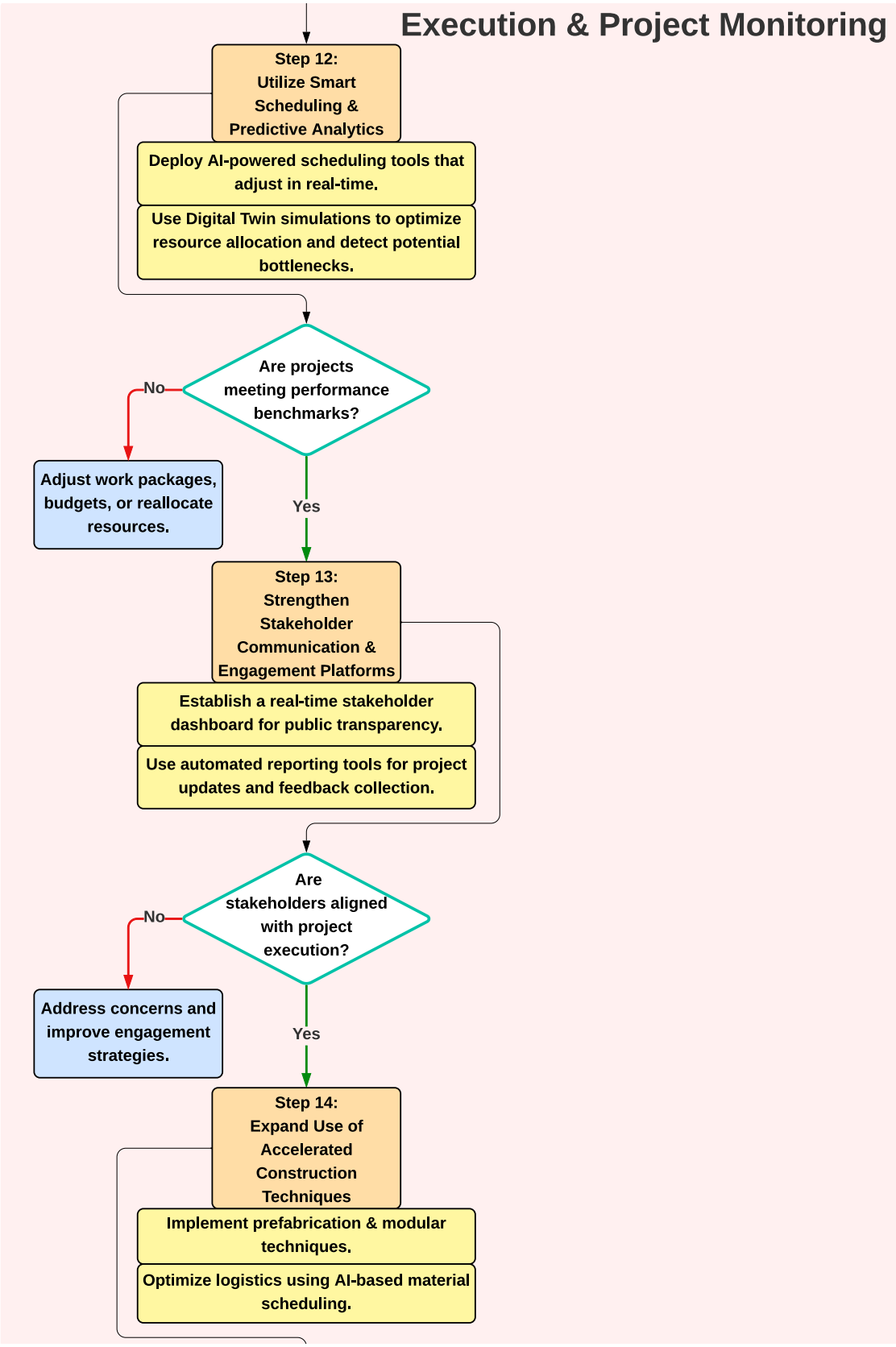

Figure 43. Section 5 of the Roadmap: Execution & Project Monitoring

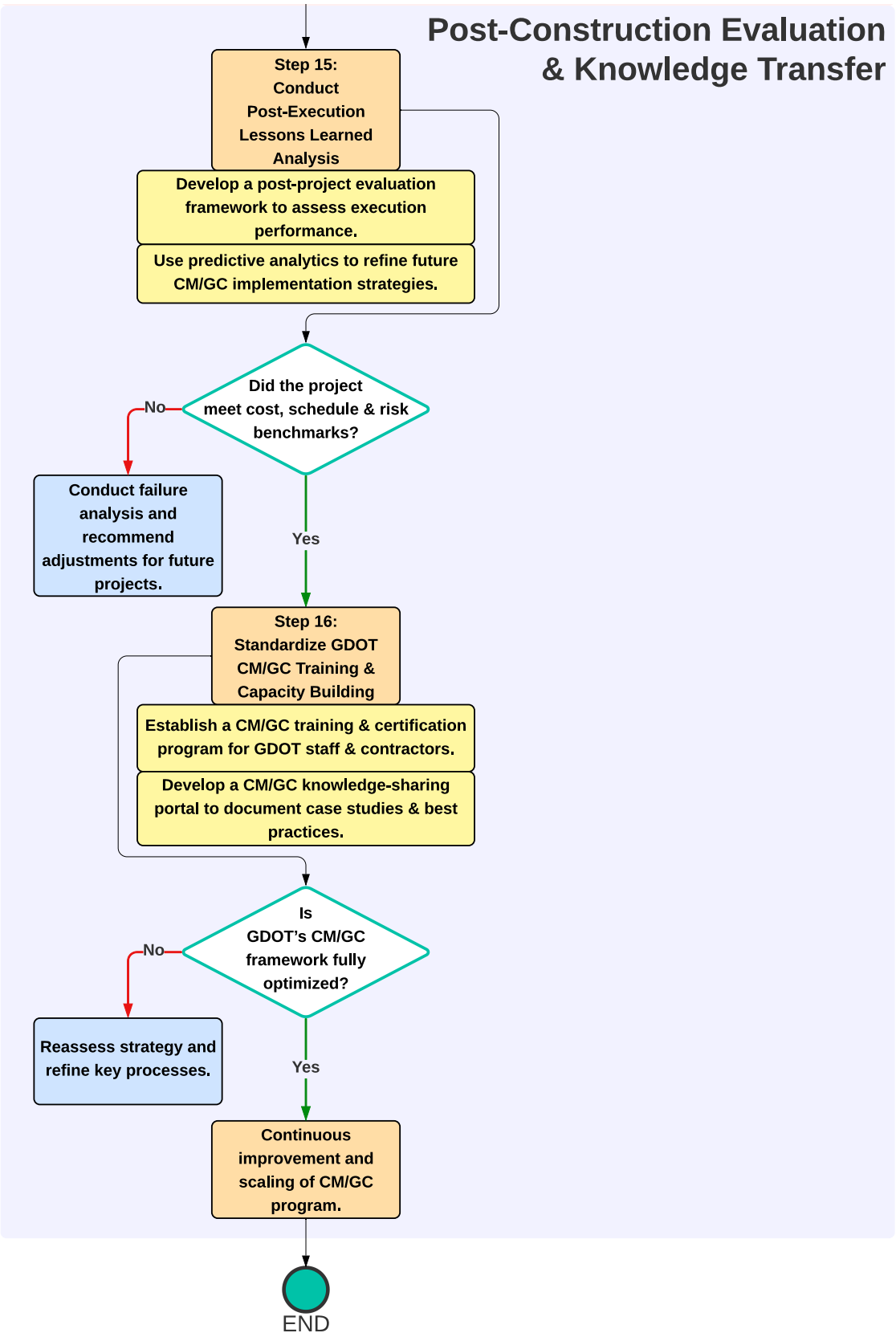

Figure 44. Section 6 of the Roadmap: Post-Construction Evaluation & Knowledge Transfer

12. CONCLUSION, POLICY RECOMMENDATIONS AND NEXT STEPS

The successful delivery of transportation infrastructure increasingly relies on flexible project delivery methods which can handle complexity, foster collaboration, and optimize cost and schedule performance. This report has evaluated the CM/GC method in detail. By contrasting it with traditional approaches such as Design-Bid-Build (DBB) and Design-Build (DB), the research team has identified several findings regarding how CM/GC can deliver tangible benefits when supported by robust risk management strategies, well-defined procurement practices, and early contractor involvement. Drawing from comparative analysis between GDOT and other DOTs, lessons learned from case studies, and expert consensus gathered via a Delphi survey, the following final observations and recommendations aim to guide GDOT's continued evolution of its CM/GC program.

12.1 Summary of Key Findings

Growing Adoption and Legislative Support

CM/GC adoption rates have accelerated in states with well-defined legislative frameworks that encourage alternative delivery. When key policy enablers are in place, projects benefit from streamlined approvals and clearer pathways to collaborative procurement. Several case studies, including Utah DOT's I-15 corridor expansion, demonstrate how strong legislative backing and a clear alternative delivery framework catalyze CM/GC adoption.

Enhanced Schedule and Budget Performance

Projects delivered using the CM/GC method generally report improved schedule compliance and budget adherence compared to those using DBB and DB methods. The early involvement of the contractor in the design phase under CM/GC minimizes delays and budget overturns. Colorado DOT's pilot projects showed that early involvement of the contractor, combined with open-book negotiations, reduced cost overruns by up to 15% compared to Design-Bid-Build (DBB).

Effective Risk Management

CM/GC projects exhibit a stronger alignment in risk management strategies, with risks being identified and mitigated earlier in the project lifecycle. Progressive Guaranteed Maximum Price (GMP) structures emerged as an effective way to allocate and manage risk.

Collaborative Project Culture

Multiple case studies underscored the value of digital collaboration platforms and frequent constructability reviews, echoing lessons from Minnesota DOT (MnDOT) projects where co-location of designers and contractors reduced request-for-information (RFI) frequency. A strong culture of trust and transparent information-sharing was cited by more than half of participants as a "make-or-break" factor in CM/GC success.

12.2 Identified Challenges and Gaps

The comprehensive analysis of CM/GC practices across multiple DOTs, combined with expert insights from the Delphi survey, reveals several critical challenges and gaps in GDOT's current

CM/GC framework. These challenges span across procurement strategies, risk allocation, digital integration, stakeholder coordination, and capacity-building initiatives, underscoring the need for targeted enhancements to achieve optimal project delivery.

Procurement and Evaluation Challenges

GDOT's existing procurement processes exhibit partial alignment with best-value principles. While early contractor involvement is recognized, the evaluation criteria often lack an explicit weighting for innovation, past performance, and risk management. This gap may hinder the selection of contractors who not only offer competitive pricing but also demonstrate the technical expertise and collaborative capabilities required for complex projects. Inconsistent adoption of formal evaluation matrices and structured decision-making tools further limits GDOT's ability to transparently compare proposals across multiple qualitative and quantitative dimensions.

Risk Allocation and Pricing Limitations

Although GDOT incorporates risk assessments during preconstruction, the framework relies predominantly on traditional cost negotiation models, such as negotiated lump sums and cost-plus agreements. The absence of dynamic risk-sharing models, such as progressive GMP structures or dynamic contingency funds, restricts financial flexibility and may lead to suboptimal cost control. Furthermore, while open-book costing practices are in place, there is limited systematic integration of independent cost estimators and regular price reviews, which are critical for ensuring budget transparency and timely adjustments in response to evolving project conditions.

Digital Integration and Constructability Reviews

The analysis indicates that GDOT's approach to constructability reviews, while incorporating contractor feedback loops, varies significantly in structure and technological support. In contrast, other DOTs have standardized digital protocols, leveraging tools like 3D/4D BIM and Digital Twins to enhance the accuracy and consistency of constructability assessments. This gap in digital integration may result in inconsistent review outcomes and missed opportunities for early detection of design conflicts, thereby affecting overall project performance.

Stakeholder Coordination and Capacity-Building Deficiencies

Effective stakeholder engagement and utility management are pivotal to successful CM/GC projects. However, GDOT currently lacks formalized frameworks for stakeholder coordination, which can lead to delayed approvals and unresolved scope conflicts. Additionally, there is a notable need for enhanced training programs and cross-division collaboration initiatives. Investment in specialized education for project managers, evaluation committees, and contractors is essential to deepen understanding of advanced risk-sharing models, procurement strategies, and collaborative project delivery techniques.

12.3 Policy Recommendations

Legislative and Regulatory Alignment

- Remove Barriers: States like Tennessee (TDOT) streamlined CM/GC adoption by clarifying procurement statutes and enabling dynamic contingency models. GDOT can work with legislators to adopt similar enabling policies, facilitating best-value procurement and flexible

risk allocation. It is recommended to for legislators to make adjustments in state and federal policies to foster a more conductive environment for the adoption of CM/GC, removing legislative and bureaucratic impediments.

- Encourage Collaborative Contracts: Develop standardized contract templates that embed early contractor involvement, a transparent GMP framework, and incentive clauses. Lessons from UDOT's I-80 reconstruction show that such measures accelerate design-finalization and reduce protracted negotiations.

Standardized Evaluation and Best Practices

- Unified Framework: A standardized evaluation tool that is similar to which used in some CDOT projects can track schedule compliance, cost metrics, and stakeholder satisfaction consistently.
- Integration of Digital Technology: Mandating digital 3D/4D BIM modeling, as pioneered by Caltrans, can streamline constructability checks.

Training and Capacity-Building

- Comprehensive Education: Develop specialized training programs focusing on GMP negotiations, risk-based pricing, and stakeholder engagement. Suggest investment in training programs for project managers and contractors to deepen their understanding of the CM/GC method, focusing on contract negotiations, risk management, and collaborative project delivery techniques.
- Cross-Division Collaboration: Encourage internal knowledge exchange through workshops in which experienced GDOT districts share their CM/GC lessons with regions still relying heavily on DBB.

12.4 Next Steps for GDOT

To advance GDOT's CM/GC program, it is imperative to enhance procurement processes by refining the contractor evaluation criteria and adopting formal decision-making tools. GDOT should develop a standardized best-value evaluation matrix that explicitly incorporates measures for innovation, past performance, and risk management. In parallel, structured procurement tools such as contract selection matrices and qualification scoring systems should be integrated into the process to ensure transparency, consistency, and improved decision-making during contractor selection.

Equally critical is the adoption of dynamic risk management frameworks. GDOT is encouraged to transition from traditional cost negotiation models, such as lump-sum or cost-plus agreements, to more flexible, risk-sharing models including progressive GMP structures and dynamic contingency funds. This shift will enhance financial flexibility and facilitate timely cost adjustments in response to evolving project conditions. Additionally, the routine utilization of independent cost estimators and the implementation of regular price reviews will further fortify budget control and financial oversight throughout the project lifecycle.

Leveraging digital tools and standardizing constructability reviews are also essential for improving project performance. GDOT should mandate the use of advanced digital collaboration platforms, such as 3D/4D BIM and Digital Twins, to streamline constructability assessments and enable real-time project monitoring. Standardized protocols for these reviews will reduce design conflicts and ensure consistency across projects, thereby enhancing overall constructability and design integration.

Furthermore, strengthening stakeholder coordination and building organizational capacity are critical to successful CM/GC project delivery. GDOT must establish formal frameworks for stakeholder engagement that include mandatory preconstruction utility coordination meetings, structured right-of-way resolution plans, and ongoing collaboration with local agencies. In addition, targeted training programs focused on advanced risk-sharing, procurement strategies, and collaborative project delivery techniques should be instituted to ensure that both GDOT staff and external contractors are adequately prepared for CM/GC projects. Cross-division workshops and collaborative sessions are also recommended to facilitate knowledge transfer between experienced and less experienced regions within GDOT.

Finally, GDOT should consider piloting these innovative practices on a select portfolio of high-complexity or high-impact projects. These pilot initiatives will serve as a testbed for the refined procurement, risk management, and digital integration strategies. Establishing data-driven benchmarks and performance dashboards to monitor these pilots is essential, as it will enable continuous feedback and iterative improvements, ensuring that GDOT's CM/GC framework evolves in alignment with both operational needs and industry best practices.

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